Introduction to Troubleshooting Cases Related to Telephone Systems in Customer Premises

Technical Assistance and Support Center, NTT EAST

Abstract

In this article, we introduce two cases involving problems that occurred in telephone systems. In the first case, a connection could not be established even when the customer dialed the correct number. In the second case, silence suddenly occurred during the connection. We investigated and solved these problems using various measurement tools and analysis methods. This is the fifty-fourth article in a series on telecommunication technologies.

Keywords: key telephone system, IP phone, PSTN

1. Introduction

The Network Interface Engineering Group at the Technical Assistance and Support Center provides technical support and on-site troubleshooting for difficult-to-solve problems in Internet protocol (IP) services such as the FLET'S HIKARI NEXT fiber-optic broadband service and public switched telephone network (PSTN) services such as plain old telephone services (POTS).

The rapid progression of information and communication technology (ICT) has led to our support of various ICT services. Thus, when we investigate the cause of a problem, we use a variety of measurement methods and equipment. For IP services, we obtain IP packets in a network using packet capture tools, and we analyze those packets using various methods. For PSTN services, we analyze signals using waveform recorders and ISDN (integrated services digital network) protocol analyzers. To inspect key telephone systems, we collect and analyze specific signals in a cable between the master equipment and terminal telephone sets using the α line monitoring system (a tool developed by the Technical Assistance and Support Center). Two recent cases of problems that occurred in customer premises are introduced in this article.

2. Introduction to troubleshooting cases in customer premises

This section describes in detail the two problems that occurred in customer premises.

2.1 Case 1: Connection cannot be established even if customer dials correct number

2.1.1 Overview and investigation method

In this case, the customer's key telephone system (αGX-M) was connected to five POTS lines. The customer claimed that a connection could not be established even if the correct number was dialed. On site, the master equipment unit and telephone sets were replaced by service personnel, but the problem persisted.

Thus, we conducted an investigation to solve the problem. This consisted of collecting and analyzing data when the problem occurred. The configuration of the measurement setup and tools used in the

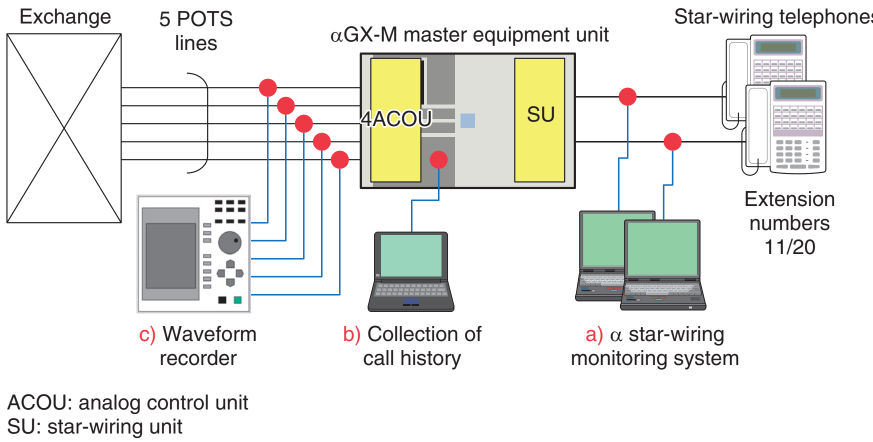


Fig. 1. Configuration of call analysis system and measurement points.

Table 1. System status at problem occurrence.

Date/time	Outside line	Extension number	Number dialed
Date/Month/2018 at 10:00	2	20	02xx-xx-xxxx
Date/Month/2018 at 10:20	3	20	02yy-yy-yyyy
Date/Month/2018 at 10:21	2	20	02zz-zz-zzzz

investigation are shown in **Fig. 1**. The red circles indicate the measurement points. We investigated the following using several measurement tools.

a) Monitoring telephone operation using the α line monitoring system
b) Collecting call history using a personal computer, that is, the maintenance console of the system, and checking the call-connection status at the time of the problem
c) Checking outgoing-call sequence/selection signals (push button (PB) signals) by monitoring the voltage between the L1-L2 lines using the waveform recorder

The customer explained that the problem occurred three times during the investigation period. After conducting the investigations above, we analyzed the collected data. The system status at the time the problem occurred is summarized in **Table 1**.

2.1.2 Results of analyzing collected data

a) α line monitoring system

When the telephone operation was checked at the time the problem occurred, it was found that the customer was operating the telephone normally by connecting to an outside line using the line key and pressing the dialing buttons corresponding to the destination telephone number.

b) Collection of call history via maintenance console

When the call history of the master equipment was checked, it was found that the number dialed by the customer on the telephone was recorded; that is, it indicated that the customer was operating the telephone correctly.

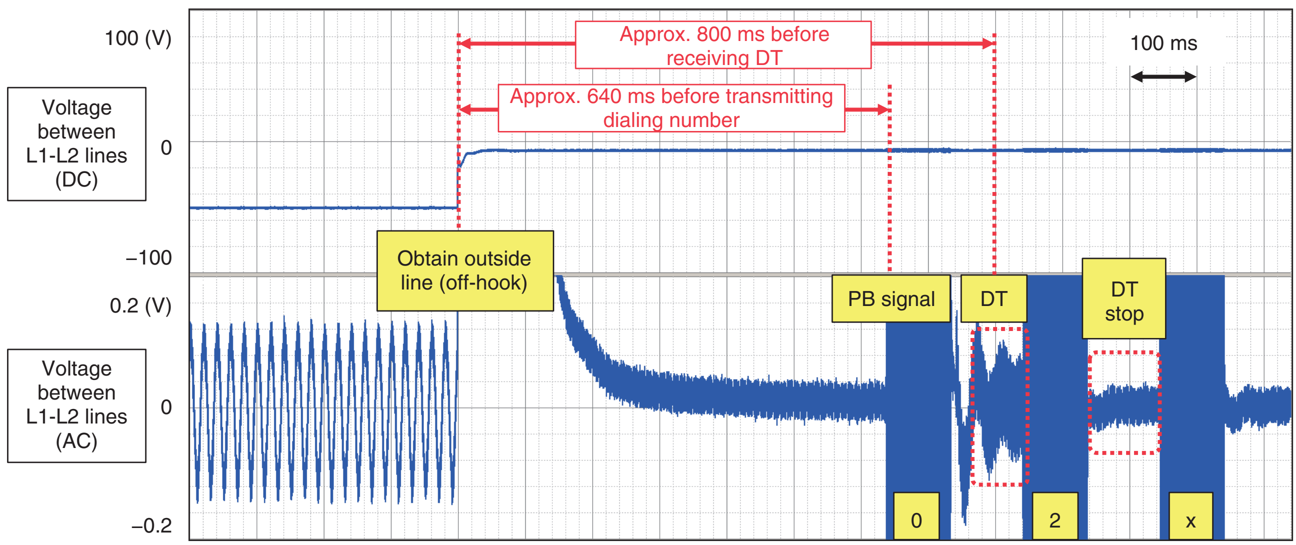
c) Voltage monitoring between L1-L2 lines by waveform recorder

The following information was obtained from the waveform recorder. The waveforms obtained when the problem occurred are shown in **Fig. 2**.

- The PB signal of the first digit dialed (‘0’) was transmitted approximately 640 to 790 ms after connecting to an outside line (loop closure).
- The dial tone (DT) was received from the exchange after the PB signal of the first digit had already been transmitted (‘0’).
- The DT stopped when the second digit was dialed (‘2’).
- It took approximately 800 to 900 ms for the DT to be received in the customer’s environment.

2.1.3 Cause of problem and countermeasure

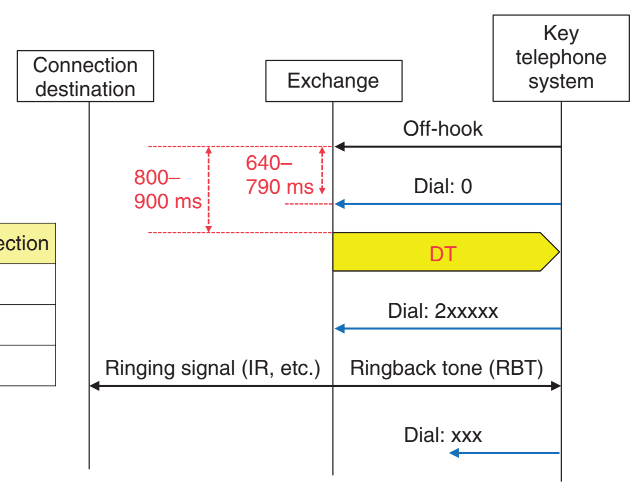
This problem occurred because the PB signal of the



AC: alternating current
DC: direct current
DT: dial tone

Fig. 2. Waveforms at time of problem.

Dialed number	Actual connection
02xx-xx-xxxx	2x-xxxx
02yy-yy-yxxx	2y-yyyy
02zz-zz-zzzz	2z-zzzz



IR: inter ringing

Fig. 3. Calling sequence at time of problem.

first digit dialed ('0') was transmitted from the telephone before receiving the DT from the exchange, preventing that digit from being recognized by the exchange. Furthermore, since the PB signal of the second digit dialed ('2') (transmitted after receiving the DT) was processed by the exchange, and given that the first digit of a local office number is '2,' a connection was made to an existing 6-digit local telephone number. The calling sequence is shown in **Fig. 3**. This problem was solved by changing the initial value of the guard interval before transmitting the first digit of the dialed number from 600 ms to 1000 ms. This can be easily set by using the αGX-M master equipment system data, that is, the 07–47 early dialing prevention timer for making an outside call. The waveforms when setting this value to 1200 ms

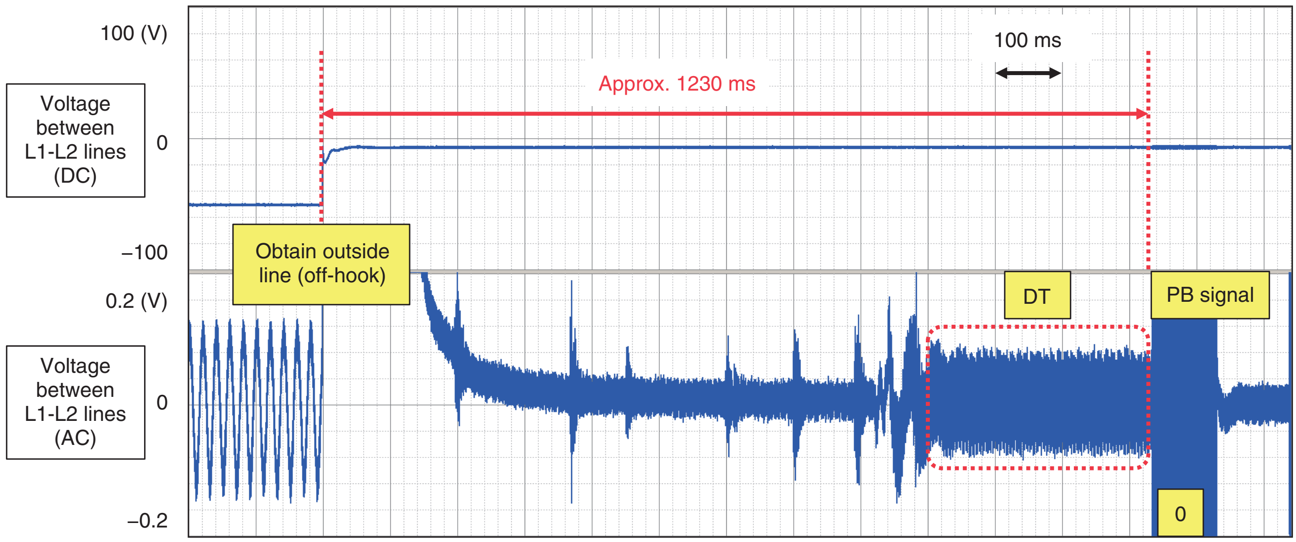
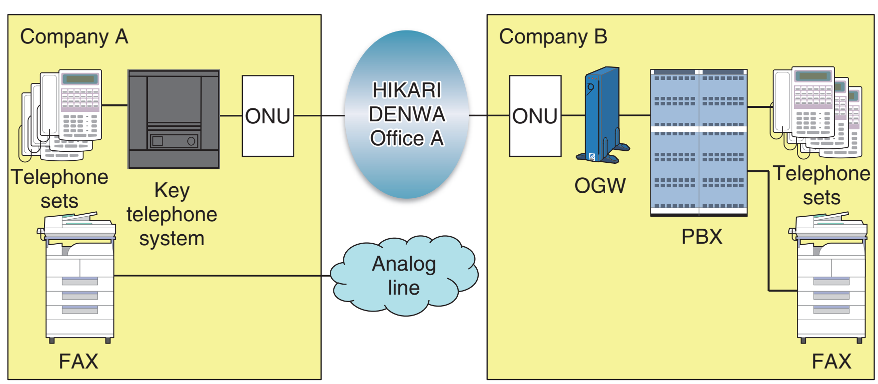


Fig. 4. Waveforms for guard interval set to 1200 ms.



FAX: facsimile
ONU: optical network unit

Fig. 5. Equipment configuration.

are shown in **Fig. 4**.

2.2 Case 2: Voice suddenly disappears in connection with specific destination

2.2.1 Overview and investigation method

A customer (Company A) was using the NTT HIKARI DENWA IP phone service in its key telephone system. The customer claimed that a voiceless condition occurred during calls with Company B. Company B, meanwhile, was using the NTT HIKARI DENWA (via OGW (Office Gateway) with Primary Rate Interface) in its private branch exchange (PBX). The equipment configuration at both locations is shown in **Fig. 5**. We captured IP packets using packet-capturing equipment near the ONU (optical network unit) at both locations. Then the data at the time of the problem occurred were analyzed.

2.2.2 Results of analyzing collected data

Six incidents were reported by the customer during the time the packet-capturing equipment was installed. The captured data revealed the following information. These were common to the six incidents.

- At Company A, the incidents always occurred when the telephone set was used on extension number 25.
- Analysis by Wireshark (local area network

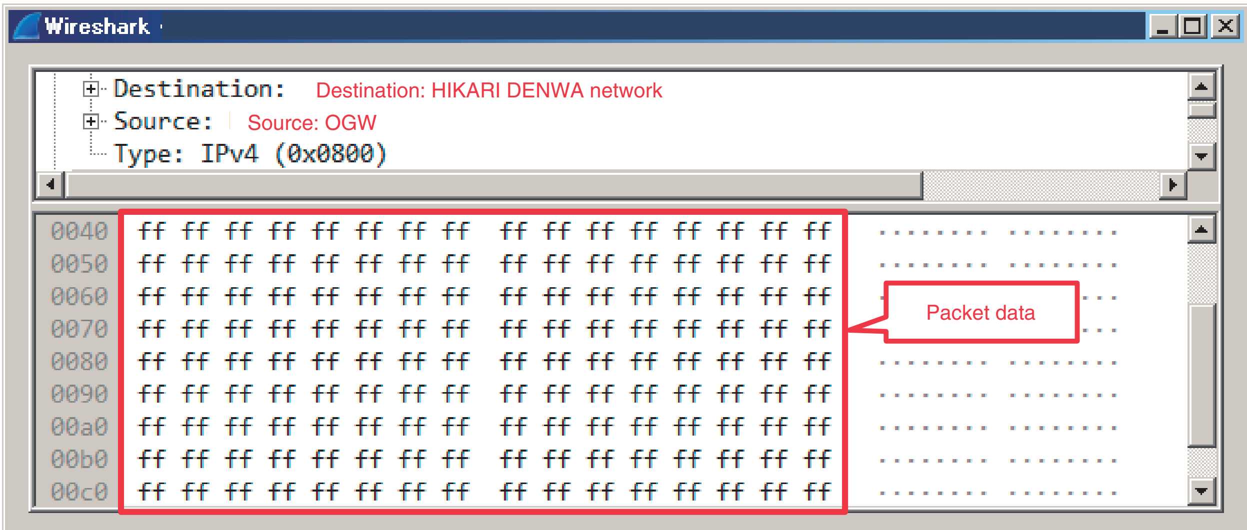


Fig. 6. Voice packet data from Company B.

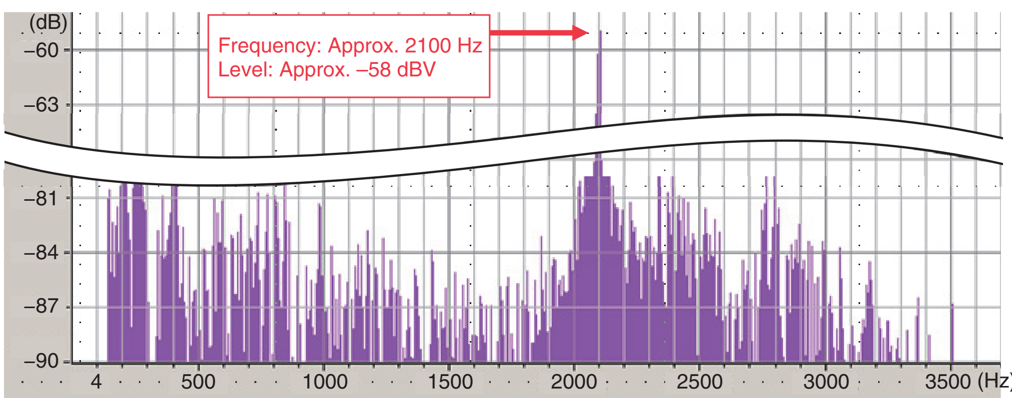


Fig. 7. Results of analyzing frequency components.

analyzer) revealed that voice packet data from Company B contained "ff," which indicates complete silence (**Fig. 6**). This state continued until the call was disconnected.

- Analysis of voice packet data indicated that the sound of facsimile (FAX) communications was mixed in with the voice call from Company A.
- This mixed-in sound is the called terminal identification (CED) tone (frequency: 2100 Hz), which is the response signal issued on receiving a FAX (**Fig. 7**).

2.2.3 Inference of cause and countermeasure

After analyzing the collected data, we inferred that one of the causes of this problem was the mixing in of the FAX CED tone from Company A during the call. Consequently, on checking the surroundings near the telephone set at Company A, we found that the telephone set having extension number 25 was installed about 1 m away from the FAX machine, and the machine was transmitting the sound of FAX communications from the speaker used for monitoring its operation. Thus, the monitor sound during FAX communications was picked up by the microphone of telephone number 25. To avoid unintended pickup of the sound, the volume of the monitor sound during FAX communications was decreased.

2.2.4 PBX operation check

In addition, we also checked the operation of the

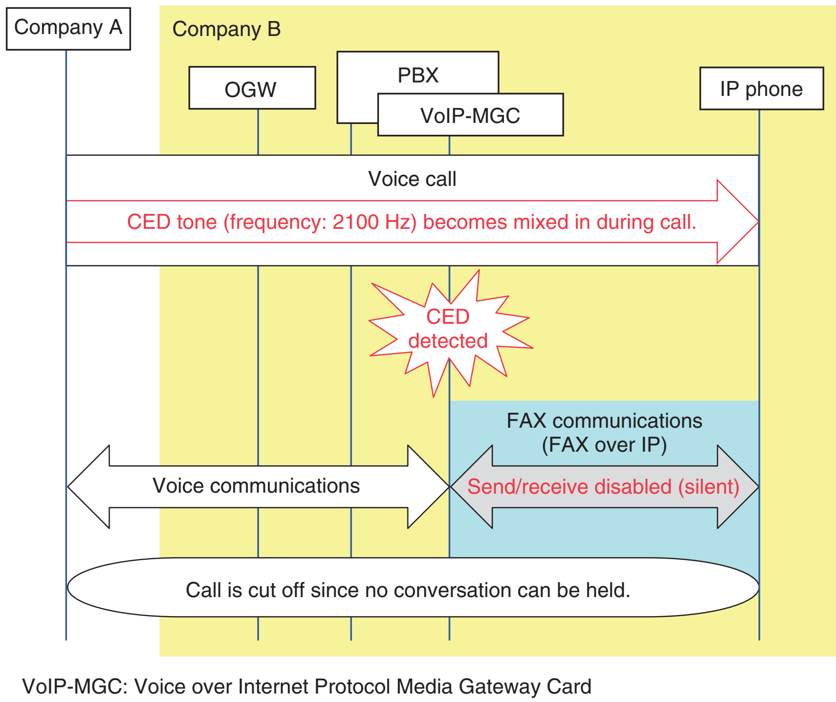


Fig. 8. Conditions of problem occurrence.

PBX at Company B. We added a 2100-Hz signal to the voice communication between Company A and Company B. As a result, the voice communication was disabled. Furthermore, on checking the specifications of the PBX equipment, we found that this problem would occur under the following conditions, as shown in **Fig. 8**.

- The equipment configuration included IP phones (with a Voice over Internet Protocol (VoIP) Media Gateway Card installed) used as extension telephones.
- The VoIP Media Gateway Card would switch to the FAX communications mode (FAX over IP) from the voice communications mode when it detected a CED tone (2100 Hz).
- A voiceless condition would occur after the card switched to FAX communications mode because the telephone set (i.e., IP phone) was not a FAX machine.

We confirmed that the equipment configuration at Company B was the same as that at Company A. This means that there was a possibility that the same problem could occur when Company B was making a call with another destination. Therefore, we proposed that the PBX (VoIP Media Gateway Card) should be set to disable the switching to FAX communications mode during a call (set FAX over IP to *disabled*). This proposal was accepted and implemented, and then problem was solved.

3. Conclusion

This article introduced two case studies of problems occurring in telephone systems in customer premises. The first one described a problem in a key telephone system caused by the timing of transmission of a dial tone in POTS. The other involved a problem in which a PBX would have a misoperation due to picking up a sound in the surrounding area. As we explained here, we use not only modern IP technologies but also conventional PSTN technologies to solve problems in the field. The Technical Assistance and Support Center will continue to provide solutions to problems in the field by using various tools and methods in order to ensure safe and secure telecommunication services.