IMS Services Test Technology for Leading Smartphones

Tsuyoshi Sato, Yasuyuki Matsuyama, Takuma Goto

[Summary] Mobile communications networks are deploying IMS services as key technology supporting conversion to All IP. The future increasing introduction of VoLTE is expected to support wireless-access-independent seamless services and linked services between carriers, requiring more efficient use of network resources in combination with QoS management technologies, as well as compatibility and improved service quality. We have developed the MD8475A Signalling Tester as a test solution for mobile communications services with special focus on IMS services test functions.

1 Introduction

Two trends have appeared recently in the mobile terminal market: advanced smartphones with built-in leading edge functions, and smartphones covering a wider price band targeting customers in Newly Industrializing Economies (NIEs). Additionally, diversification is proceeding into modules for so-called wearable terminals and Machine to Machine (M2M) applications where the number of terminals is following a global expansion scale. As a result, growth of mobile network capacity and usage efficiency has become an important topic. On the other hand, the spread of Long Term Evolution (LTE technology) has marked the start of voice services using Voice over LTE (VoLTE) technology. With the introduction of VoLTE, voice services, which used to be handled via circuit-switched networks, are transitioning to packet switched networks making more efficient use of network resources. Moreover, Internet protocol Multimedia Subsystem (IMS) services, which is a basic VoLTE technology, support plans to add value-added Rich Communication Suite (RCS) services offering multimedia services other than voice, such as presence and chat, file transfers, etc. In these conditions, it is clear that service connections from mobile handsets will soon become 'All IP.' During this period of massive change, there are various issues about how to maintain the quality of IMS services for mobile communications.

2 Maintaining Quality of IMS Services

2.1 Service Diversification

IMS services use Voice over IP technology (VoIP) used previously by Internet telephony. Since VoIP references RFC used by the Internet communications technology standardization group, it is only possible to establish either Peer to Peer (P2P) or client-server configurations for this test environment. However, requirements for a VoLTE test environment are increasing with a viewpoint of the mobile technology based on RFC if mobile terminals support IMS services. For example, attention must be focused not only on simple evaluations for voice qualities, but also on voice calls while Web browsing, mobile emergency call technologies, roaming technologies, and seamless services such as Single Radio Voice Call Continuity (SRVCC) with existing 3G networks.

2.2 Specifications Diversification

The main IMS services offered by smartphones are implemented as various functions described in the various 3GPP, GSMA, RFC, OM, etc., standards. Additionally, the contents of supported protocol messages differ with each operator and vendor, requiring various test environments and conditions. Performing quality evaluations requires knowledge of various fields, making it difficult to configure a general-purpose test environment.

2.3 High-quality IMS Services

With conversion to All IP technology, all services are offered over packet-switched networks. For example, a variety of services such as Internet Web browsing, voice calls, video calls, file transfers, etc., can be used in combination. However, if the optimum quality cannot be managed for each service separately, there is a possibility of disconnection if the voice or video call cannot be heard well. Although the QoS technology for assuring this quality has been defined, evaluation of this QoS technology is an important issue.

3 Requirements for Assured Quality

3.1 Service Diversification

Figure 1 shows the common IMS Regist sequence. To extend the functionality of VoIP based on Internet communications technology, VoLTE is configured from a SIP signaling section (bottom of Fig. 1) on a packet-switched network established by a conventional LTE wireless signaling section (top of Fig. 1). Evaluating this signaling requires a test environment that can perform simultaneous LTE wireless signalling and SIP signalling.

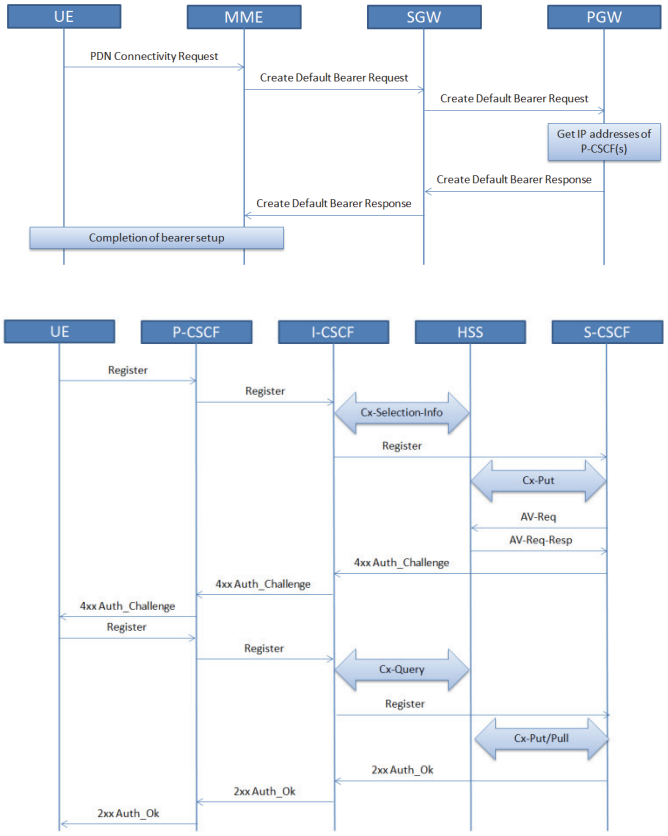


Figure 1 IMS Regist
(P-CSCF Discovery (top), SIP Signalling (bottom))

Moreover, implementing SRVCC evaluation requires provision of the general configuration for LTE, W-CMDA, EPC, CS, and IMS shown in Figure 2.

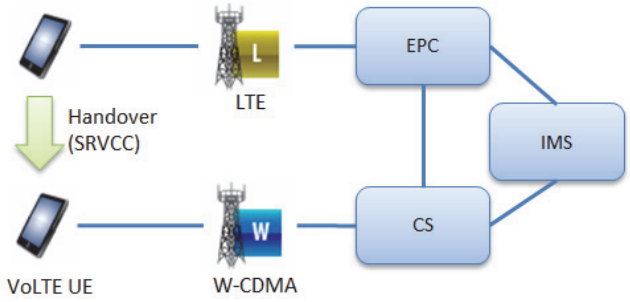


Figure 2 SRVCC Architecture

3.2 Specification Diversification

At VoLTE evaluation, creation of scenarios used for evaluation requires a good understanding of the standards and operator specifications as well as a lot of effort to create the actual scenarios. When evaluating the SIP signalling section, it is necessary to provide a test environment operating as a state machine at the LTE wireless signalling section. Moreover, when evaluating voice quality, it is best to implement an easy test environment for VoLTE connection by setting simple parameters at both the SIP signalling and LTE wireless signalling sections.

Moreover, since understanding the voice call and packet connection status requires both confirmation of each signalling protocol message as well as an understanding of the standards, it is better to use displays giving an intuitive grasp of the evaluation targets.

3.3 High-quality IMS Services

Since SIP signalling when using voice services and voice data communications requires 'real-timeness,' higher priority is required than conventional packet communication services like Web browsing and FTP transmissions, making QoS-technology based bearer management a key point. QoS for LTE is managed using a QoS Class Identifier (QCI). The network establishes the default EPS bearer correspond to the service requested by the mobile. For example, QCI = 9 when using APN for the Internet service and QCI = 5 when using APN for the IMS service, where QCI is a numeric value defining the priority of packet communications (Table 1). Figure 3 shows the procedure for establishing the voice data bearer using the IMS session procedure when calling a voice service from an IMS/VoLTE client by establishing a wireless bearer for SIP signalling. The voice bearer has a QCI of 1 meaning it has the highest priority and is linked as the dedicated EPS bearer to the default EPS bearer for SIP signalling. This requires provision of a test environment offering easy setting and display of QoS-related test conditions.

Table 1 QoS List

QCI	Resource Type	Priority level	Packet Delay Budget	Packet Error Loss Rate	Example Services
1	GBR	2	100 ms	10^2	Conversational Voice
2		4	150 ms	10^3	Conversational Video (Live Streaming)
3		3	50 ms	10^3	Real Time Gaming
4		5	300 ms	10^6	Non-Conversational Video (Buffered Streaming)
5	Non-GBR	1	100 ms	10^6	IMS Signalling
6		6	300 ms	10^6	Video (Buffered Streaming) TCP-based (e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
7		7	100 ms	10^3	Voice, Video (Live Streaming) Interactive Gaming
8		8	300 ms	10^6	Video (Buffered Streaming) TCP-based (e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
9		9			

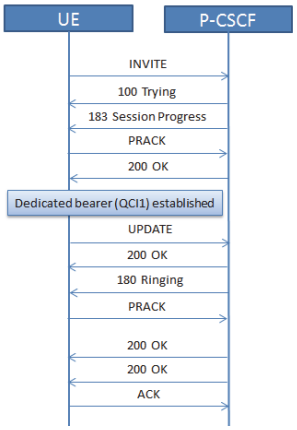


Figure 3 Mobile Origination Procedure

4 Using MD8475A

The Anritsu MD8475A Signalling Tester is a base-station simulator offering a test environment for mobile terminals. It supports multiple communication standards, including LTE, W-CDMA, TD-SCDMA, GSM, CDMA2000, etc. Combining the SmartStudio application running on the MD8475A with IMS services supports easy configuration of a test environment for testing multi-system mobiles starting with LTE as well as QoS tests of mobile services and functions when a user carries the mobile between cells.

Figure 4 MD8475A Signalling Tester

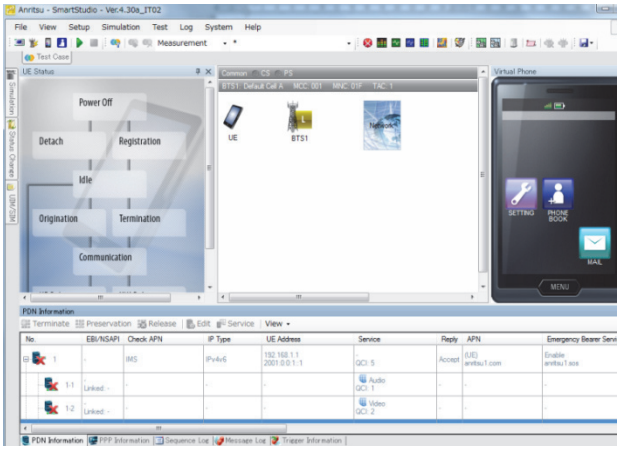


Figure 5 SmartStudio Main Screen

4.1 Service Diversification

SmartStudio offers a complete IMS services network environment in a single tester. Consequently, as shown in Figure 6, it has a GUI for changing the base station output time to simulate cell control and communications while moving, and supports pseudo-normal and abnormal testing, which are difficult to perform on a live network, emergency call tests, which are also hard to perform on a live network, tests when moving between cells when the radio environment changes, or mobility tests such as SRVCC due to external factors affecting the other user. In addition, SmartStudio can also be used to configure a VoLTE test environment for the Carrier Aggregation technology now used by the latest smartphones supporting LTE-Advanced technology.

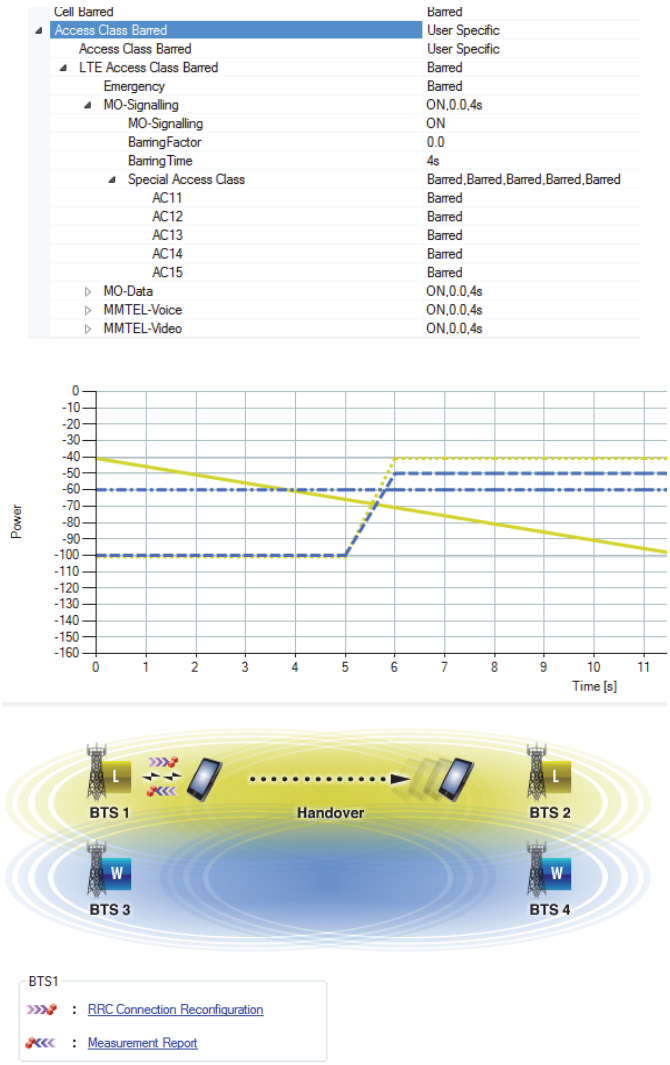


Figure 6 Cell Regulation Mobility Test using SmartStudio

The SmartStudio Mobility Test performs the handover operation while confirming the connection with the terminal under test (Figure 7 IMS Services Screen). It can be used to confirm a specific sequence as images of actual usage corresponding to the IMS service status, such as the normal SRVCC, a-SRVCC prior to starting communications, and the SRVCC during an emergency call connection.

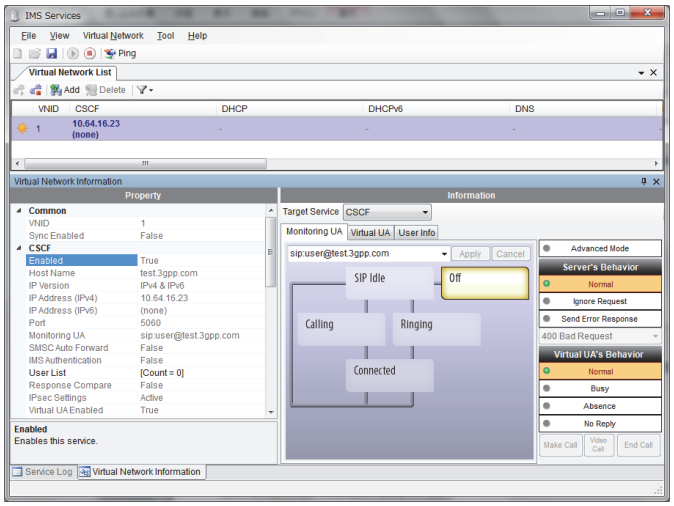


Figure 7 SmartStudio IMS Services Screen

4.2 Specifications Diversification

SmartStudio is a state-machine based application for easy configuration of a test environment simply by setting parameters. As described in section 3.2, creating VoLTE evaluation scenarios based on standards and operator parameters requires a lot of time and effort, but SmartStudio makes configuration of the required evaluation test environment as easy as changing LTE and IMS-related parameters. For example, evaluation of VoLTE battery standby time, which is one element of service quality, is not just a test of continuous communications for a fixed time under stable conditions, but also requires configuring an environment simulating a complex sequence of patterns like a driving test. At a driving test, the communications conditions are unstable as the vehicle moves between cells. It can be implemented simply by modeling the statistical data captured from the actual network and combining the wireless bearer and IMS service state by generating periodic mobility movements based on Multiple PDN. Because SmartStudio can configure complex automated test environments by making use of the features of a state machine, it is ideal for application to difficult test environments where the number of modeled simulation patterns increases and reproducibility is poor due to the changing measurement environment, such as battery consumption measurement while driving through a changing urban environment.

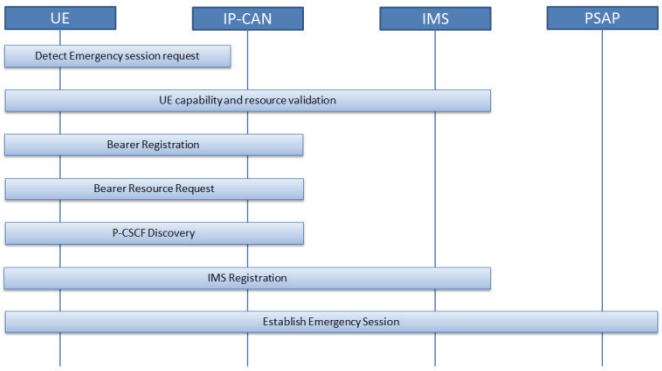


Figure 8 IMS Emergency Call

Emergency calls when either the SIM/UIM is invalid or the mobile is in the Limited Service status are examples where use of a simulator is effective. SmartStudio can add Emergency Categories and Emergency Numbers to country and region lists on the attach procedure. Additionally, when the mobile cannot be authenticated because the SIM/UIM is not recognized, a sequence can be added to connect by automatically skipping the authentication sequence. It also supports configuration of a test environment combining categories, such as special-category SIM/UIM, expandable Spare-bit categories, and Police, Ambulance, Fire Brigade, Coast Guard, Mountain Rescue, etc., categories that are difficult to test on live networks.

Emergency Number List	
Emergency Number Information 1	Enable,119
Emergency Number Information	Enable
Emergency Service Category	OFF,ON,ON,OFF,OFF,OFF,OFF,OFF
Police	OFF
Ambulance	ON
Fire Brigade	ON
Marine Guard	OFF
Mountain Rescue	OFF
Spare (Bit6)	OFF
Spare (Bit7)	OFF
Spare (Bit8)	OFF
Emergency Number	119
Emergency Number Information 2	Disable
Emergency Number Information 3	Disable
Emergency Number Information 4	Disable
Emergency Number Information 5	Disable
Emergency Number Information 6	Disable
Emergency Number Information 7	Disable
Emergency Number Information 8	Disable
Emergency Number Information 9	Disable
Emergency Number Information 10	Disable

Figure 9 Emergency Number List

Additionally, a VoLTE simulation environment can be configured at each of two MD8475A units for end-to-end connection of two IMS services mobiles. Since one objective of IMS services is offering integrated services to mobiles linked by different operators, compatibility testing between operators is expected to increase and this setup offers a means for effective reproduction, troubleshooting and analysis of problems in the field.

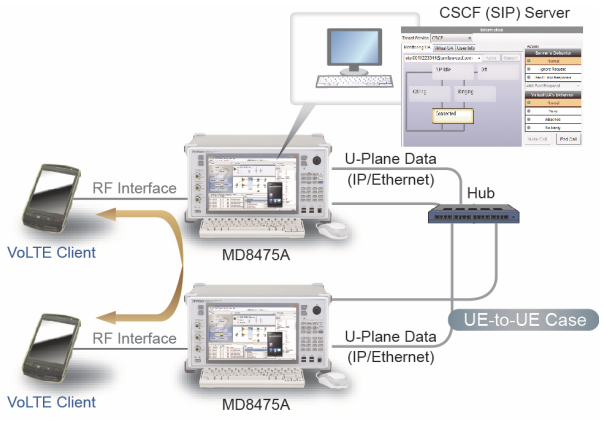


Figure 10 End-to-End Communicating Test

The IMS service groups and test functions supported by SmartStudio are listed in the following table.

Table 2 SmartStudio IMS Service Groups

Server	Service Outline
CSCF (Call Session Control Function)	In addition to standard server functions for VoLTE and SMS over IMS tests, supports voice data loopback function; also supports IPsec
DHCPv6 (Dynamic Host Configuration Protocol v6)	Allocates IPv6 addresses to network nodes and performs DNS/SIP server address notification
DNS (Domain Name Server)	Operates as DNS cache server
NDP (Neighbor Discovery Protocol)	Provides function for sending RA (Router Advertisement) in response to RS (Router Solicitation), as well as function for sending RA periodically
NTP (Network Time Protocol)	Sends time in response to NTP request and synchronizes mobile and MD8475A times
PSAP (Public Safety Answering Point)	Provides UA function for simulating emergency response body (PSAP) to perform IMS Emergency test and voice data loopback function
XCAP (XML configuration access protocol)	Performs operations, such as update, reference, delete, etc., for XML-format file data (XCAP document)

4.3 IMS Services Requiring High Quality

SmartStudio operates as an actual mobile user. In other words, assuming a scenario where multiple bearers are requested when Web browsing and using voice services, it lists the PDN information, arranges the EPS bearer start screens at the screen top, and manages the typical parameters.

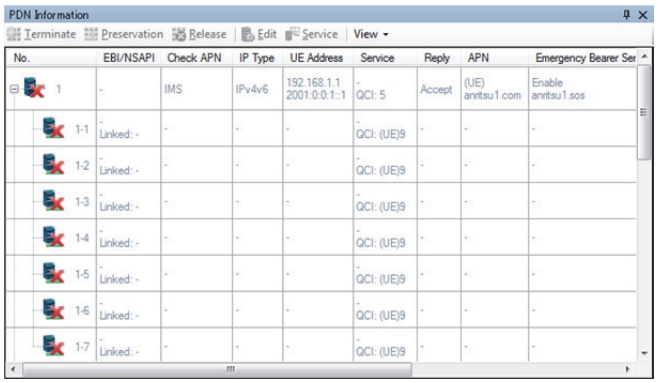
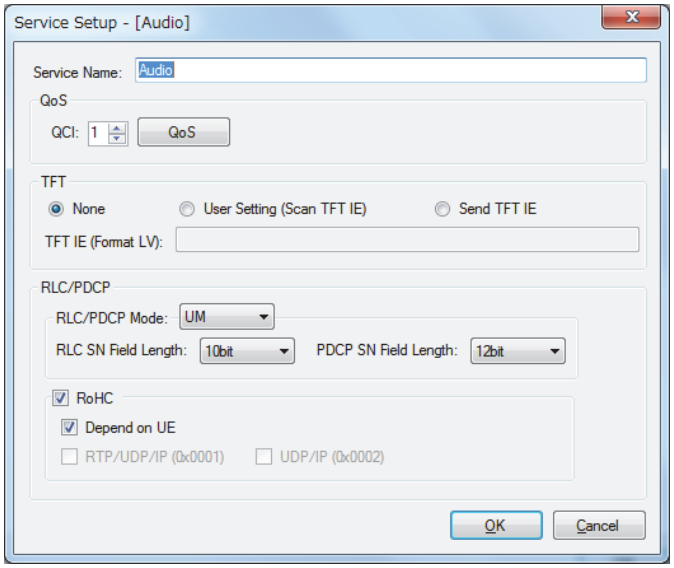


Figure 11 PDN Information List

In addition, as shown in Figure 12, it can also set the service packet communications conditions and the service QoS settings. As a result, it can be used to evaluate the quality and communications conditions of services with various QoS controls.



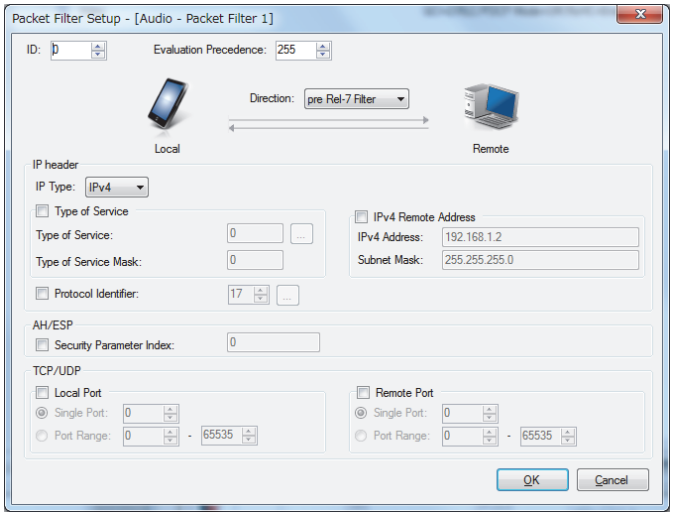


Figure 12 Service Parameter Settings (top)
TFT Parameter Settings (bottom)

5 Summary

Quality testing technology is becoming an issue as IMS services and specifications become more diversified. We have implemented a test solution focusing on the key importance of mobile operator compatibility for IMS services combining various mobility and emergency call tests.

Conversion to the more efficient All IP technology is gathering pace as IMS services are expected expand into MMS, raising various new test requirements and technical issues.

We are working on more solutions to solve the technical issues and improve the quality of mobiles typified by smartphones to support future market trends.

Reference

1) J. Tanaka, Y. Matsuyama, T. Goto,
"Test device and test method for mobile communication terminal", Patent Number P5290359, Jun. 2013.

Authors

Tsuyoshi Sato
R&D Division
Product Development Division
2nd Product Development Dept.

Yasuyuki Matsuyama
R&D Division
Product Development Division
2nd Product Development Dept.

Takuma Goto
Anritsu Engineering Co., Ltd
1st Business Div.
Mobile System Dept.

Publicly available