WLAN | IEEE 802.11a | FMC

Technology Reports

FOMA/WLAN Dual Terminal (onefone)

This terminal implements the new IEEE 802.11a to meet the diverse needs for area construction in addition to the previous FOMA/WLAN dual terminal functions. It also implements VoIP and i-mode Over WLAN on the NTT DOCOMO in-home WLAN service (Home U).

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1. Introduction

The rapid rise in use of WLAN is promoting the introduction of Internet Protocol (IP) telephony for internal communication in corporations. NTT DOCOMO has been providing the PASSAGE DUPLE service using FOMA/WLAN dual terminals. Previous FOMA/WLAN dual terminals (FOMA N900iL/N902iL) [1][2] have been used as extension lines in private exchange telephone systems, but with the growth of the Fixed Mobile Convergence (FMC)[*1] market and the appearance of the fixed-rate voice services of other companies, the need for consumer service development has risen. In addition to aiming for greater radio frequency usage to prevent interference from electronic devices that are equipped with Bluetooth®[*2] and household appliances such as microwave ovens that also use the 2.4 GHz band [3][4] of the public radio spectrum, there is also a need to adopt Institute of Electrical and Electronics Engineers (IEEE) 802.11a[*3] (hereinafter referred to as "11a") [5]. The objective of developing the FOMA/WLAN dual terminal (onefone) was to expand the user base even beyond that of the previous FOMA/WLAN dual terminals by being able to cope with new services and to satisfy the needs of adopting new wireless technology.

In this article, we present an overview of the onefone and explain implementation in mobile terminals that takes into account the technical requirements of 11a and scan/handover, implementation of a simple WLAN set up, Session Initiation Protocol (SIP)[*4] technology for implementing the IPsec and i-mode functions to maintain secure communication over Home U, and control technology for use in the WLAN module when using the device for FOMA in other countries.

2. Overview of onefone

2.1 Comparison with Existing FOMA/WLAN Dual Terminals

The external view of the onefone is shown in **Photo 1** and the basic specifications are listed in **Table 1**.

The onefone is based on the FOMA N905i in both hardware and software, with functions added for WLAN, Flash® Video (FLV)[*5], and Windows Media® Video (WMV)[*6]. The FOMA 1.7 GHz band and the One seg tuner of the FOMA N905i are not included. The WLAN function is based on the FOMA N902iL and implements 11a (5 GHz) as well as the previous IEEE 802.11b[*7] (2.4 GHz, hereinafter referred to as "11b") and IEEE 802.11g[*8] (2.4 GHz, hereinafter referred to as "11g"). There is no signal mixing with the existing IEEE802.11b/g (11b/g), so communica-

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*1 **FMC**: A form of communication service that fuses mobile and fixed communications, allowing mobile phones to be used as extension phones to fixed-line phones in the home, etc.
*2 **Bluetooth®**: A registered trademark of Bluetooth SIG Inc. in the United States.
*3 **IEEE 802.11a**: Wireless specifications defined by IEEE that support transmission speeds of up to 54 Mbit/s using the 5.2 GHz band.
*4 **SIP**: A call control protocol defined by the Internet Engineering Task Force (IETF) and used for IP telephony with VoIP, etc.
*5 **FLV**: A video file format used in Flash. Flash® is a registered trademark of Adobe Systems Inc. in the United States and other countries.

tion using frequencies that are different from those used for data communication by PCs and other such devices is possible. Also, accommodating the Home U service makes it possible to provide voice and data communication over WLAN in the home, and so target the personal use market in addition to the traditional business user. This mobile terminal uses the FLV and WMV functions to allow replay of large-volume Internet video with full browser capabilities. It is also possible to upload video data to video collection sites and blogs, so that video materials can be enjoyed on a mobile terminal, with no need to connect via a PC.

2.2 Expansion of Network Services

The onefone can be used with the consumer-oriented Home U IP telephony service as well as with the NTT DOCOMO PASSAGE DUPLE internal communication service and the enterprise-oriented IP telephony service Business Mopera IP Centrex. The concept of the Home U service is shown in **Figure 1**. IP telephony is available inside the home using the WLAN environment set up in the home and a broadband line, and FOMA communication can be used outside. Also possible are access to i-mode public content, i-mode mail, and use of a full browser over the WLAN, allowing faster data transmission and reception than when using FOMA communication.

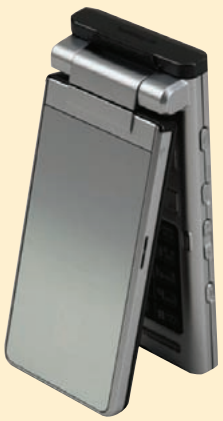

Photo 1 The onefone (FOMA N906iL)

3. Incorporating New Technology

3.1 Dealing with Restrictions on the Use of WLAN

In addition to the 11b/g WLAN specifications implemented by the FOMA N902iL, the onefone adopts the 5 GHz band 11a specifications. The 11b/g uses the 2.4 GHz Industry-Science-Medical (ISM) band[*9], but that band is also used by microwave ovens and Bluetooth devices, so radio frequency interference may reduce communication quality. Furthermore, when the high transmission rate 11g is used, only three channels are available for area construction because of the interference problem. Area design with the

Table 1 Basic specifications of the FOMA N906iL

	FOMA N906iL	FOMA N902iL (Reference)
Radio frequency band	800 MHz/2 GHz (FOMA) 900 MHz/1800 MHz/1900 MHz (GSM) 2.4 GHz/5 GHz (WLAN)	800 MHz/2 GHz (FOMA) 2.4 GHz (WLAN)
Size	109×49×19.6 mm	106×51×25 mm
Weight	Approx. 127 g	Approx. 123 g
Continuous call time	Approx. 220 minutes (voice) Approx. 100 minutes (videophone) Approx. 200 minutes (WLAN)*1*2 Approx. 200 minutes (Home U)*1*2	Approx. 160 minutes (voice) Approx. 100 minutes (videophone) Approx. 250 minutes (WLAN)*1*2
Continuous standby time	Approx. 600 hours (FOMA) Approx. 480 hours (WLAN)*1*3 Approx. 330 minutes (Home U) *1*3	Approx. 500 hours (FOMA) Approx. 400 hours (WLAN)*1*3
LCD	Main LCD 3.0 inches 480×854 dot Back LCD 0.9 inches 96×64 dot	Main LCD 2.5 inches 240×345 dot Back LCD 0.9 inches 120×30 dot
Main camera	2 million pixels CMOS	1.25 million pixels νMaicovicon®*4
WLAN system	IEEE 802.11a/b/g compliant	IEEE 802.11b/g compliant
WLAN speed	Up to 54 Mbit/s	Up to 54 Mbit/s

*1 The continuous call time and continuous standby time vary with the WLAN signal conditions and the N906iL and access point settings.
*2 Value for when the power-save function is turned off.
*3 Value for when the mode is WLAN single without moving.
*4 νMaicovicon®: A registered trademark of Matsushita Electric Industrial Co.,Ltd.

*6 **WMV**: A video compression scheme and file format developed by Microsoft Corp. Supports streaming play and download play.
Windows Media® is a registered trademark of Microsoft Corp. in the United States and other countries.

*7 **IEEE 802.11b**: A wireless standard defined by IEEE that supports a transfer rate of 11 Mbit/s.

*8 **IEEE 802.11g**: A wireless standard defined by IEEE. Adopts the same 2.4 GHz frequency band as 802.11b and supports a transfer rate of 54 Mbit/s. The transmission speed is the same as 802.11a, but this specification is compatible with 802.11b.

*9 **ISM band**: A radio frequency band in the neighborhood of 2.4 GHz. In Japan, no license is required for transmitting in this band at 10 mW or less. It is used for industrial, scientific and medical purposes.

limited channels requires advanced design technology. That problem is solved by using 11a, which is not susceptible to interference from other devices and allows the use of up to eight channels.

However, regulation by the Radio Law in Japan prohibits the use of 11a outdoors. Existing 11a devices (PCs, etc.) are restricted to using Passive Scan[*10] outdoors. This mobile terminal also implements Passive Scan, but this scanning method cannot be used together with the stealth Service Set IDentifier (SSID)[*11] security measures. Also, while it is assumed that this GSM-capable mobile terminal may be carried abroad, there are some GSM countries, like Japan, that prohibit the use of 11a outdoors and others that prohibit WLAN that include 11b/g. The measures listed below deal with these restrictions on WLAN use.

1) When it is determined that the site is outside of Japan, WLAN is disabled (only FOMA can be used)

If the country code reported by the FOMA signal is other than "Japan," WLAN is disabled and the specifications are switched to the FOMA single mode. In this way, the user can take the GSM terminal abroad without having to manually change the WLAN settings, even on trips to countries where the use of WLAN is prohibited.

2) When using 11a, radio transmission is halted until it can be determined that the location of use is indoors

The concept of disabling use of 11a outdoors is shown in **Figure 2**. To address the problem of the simultaneous inhibition of outdoor use of signal transmission and the ActiveScan function that is required for stealth SSID, which is in strong demand by corporate users, we implemented specifications in which no signal is transmitted from the mobile terminal unless a WLAN Access Point (AP) is detected. That makes it possible to use 11a with no reduction in the level of security and no need for the user to consider whether they are indoors or outdoors.

3.2 WPS Functions

When using the Home U service, the user must do a wireless setup and a

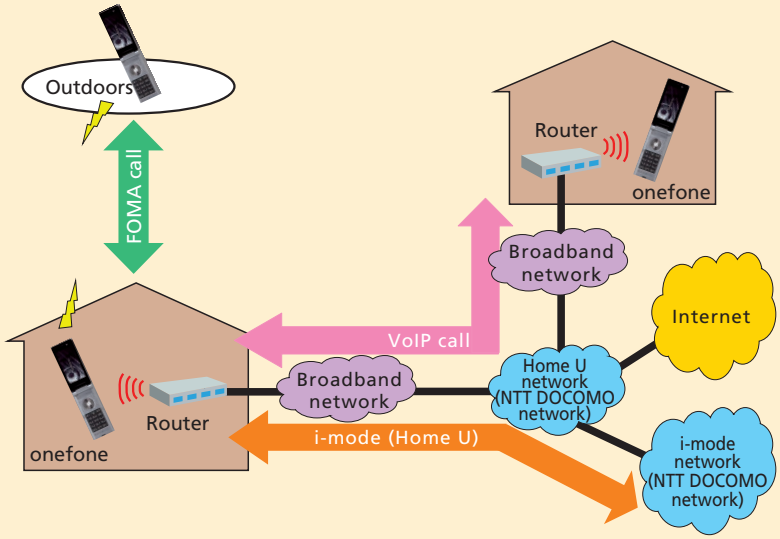

Figure 1 Home U service

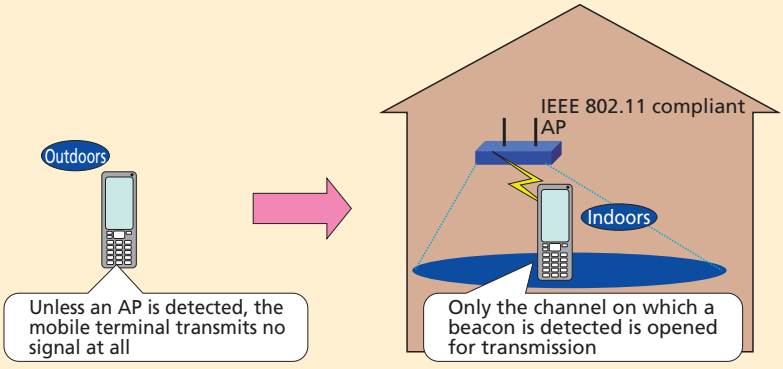

Figure 2 Disabling IEEE 802.11a outdoor use

*10 **Passive Scan**: A method that allows WLAN devices to search for access points. It is a passive method that operates by receiving a beacon signal.
*11 **SSID**: An access point identifier in an IEEE 802 series WLAN.

network setup for the radio access point and the router being used. This setup is complicated, so errors in input or in choosing the settings may occur. The previous Wi-Fi Protected Setup (WPS)[*12] function can only handle wireless setup, but for onefone that function is extended to perform the NTT DOCOMO Home U service network setup. Thus, the user can use the Home U service without having to do complex setup. Furthermore, while the previous AP setup had required use of a PC, the Home U service can be used without a PC.

4. Home U on Mobile Terminals

By connecting to the NTT DOCOMO network via the in-home Internet environment, the Home U service implements various services that are already provided by FOMA over the WLAN. The services provided include voice calls using SIP (VoIP) as well as i-mode mail and Web browsing [6].

4.1 Security in Home U

In the FOMA network, the confidentiality of the data and telephone services is guaranteed by the security and control systems established by the NTT DOCOMO network. With the Home U service, however, it is also necessary to ensure communication confidentiality over the Internet link and the wireless link within the home, where NTT DOCOMO has no control. It is therefore necessary to adopt security and control systems that differ from those of FOMA.

As a security measure specific to the Home U service, onefone uses IPsec for convenience in use and to ensure security. IPsec is an encrypted communication security technique that guarantees confidentiality and integrity on the IP-layer level in units of the IP packet. It guarantees security of data (including voice data) between a onefone and an IPsec terminating equipment on an NTT DOCOMO network. When using the Home U service, onefone automatically establishes IPsec for the NTT DOCOMO network. All of the data sent and received is then encrypted, so secure communication with a third party over the Internet and the in-home wireless link is guaranteed.

The IPsec tunnel setup sequence for onefone and the NTT DOCOMO network is shown in **Figure 3**. Setting up an IPsec tunnel is broadly divided into two Exchanges (the minimum unit of message exchange). The initial IKE_SA_INIT message and the follow-

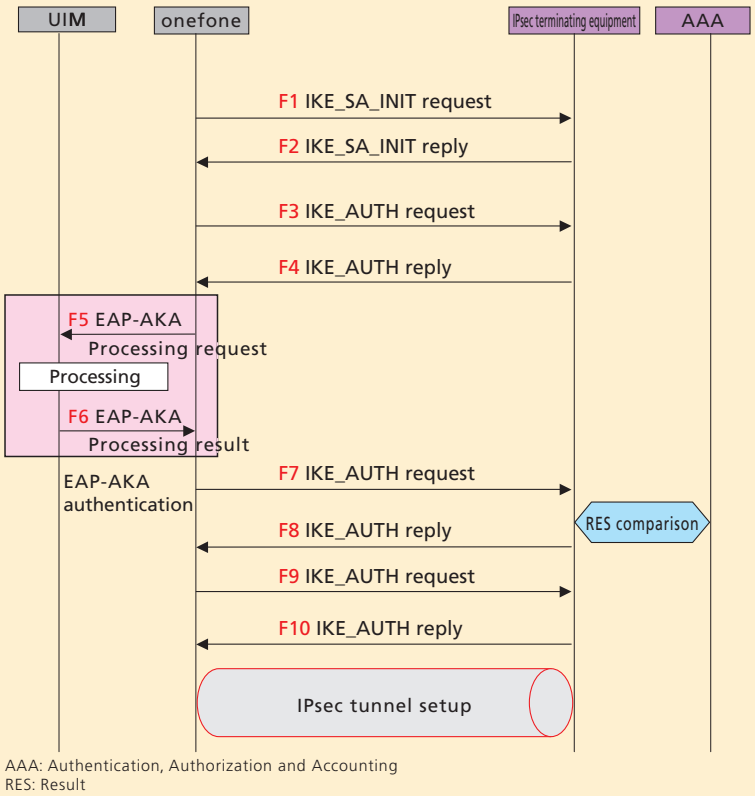

Figure 3 IPsec tunnel setup sequence

*12 **WPS**: A Wi-Fi Alliance specification that allows easy WLAN device connection and security setup.

ing IKE_AUTH message exchange the information for establishing the IPsec tunnel.

In the first Exchange, IKE_SA_INIT, pre-negotiation for encryption is executed to allow negotiation of the parameters under secure environment in the IKE_SA step. That allows the next step to be executed securely with IKE_SA encryption.

Next, negotiation for the encryption method within IPsec that is to be actually used and authentication of the other party are performed. In deciding on the encryption method, the negotiation prescribed in the standards is used, but in the other-party authentication in the Home U service makes use of the existing mobile phone feature to use Extensible Authentication Protocol-Authentication and Key Agreement (EAP-AKA).

EAP-AKA authentication uses a UIM card that is specific to the mobile phone user. It is used in the Third-Generation (3G) mobile communication system. EAP-AKA authentication has high development efficiency because of the large commonality with FOMA functions. It is also more convenient for the user because input of an ID or password is not required.

4.2 Push Functions Using SIP

Current FOMA services such as mail and the i channel are implemented by sending a notification of the arrival of mail or the updating of data to the mobile terminal with special 3G communication control signals. The mobile terminal then tries to retrieve the information from the server. Home U, however, provides IP services, so the existing 3G control signals cannot be used. Therefore, to provide the same kinds of services over IP as are offered by 3G, we define a new control signal that uses the SIP MESSAGE method[*13] for service provision over Home U.

5. Conclusion

The onefone is a mobile terminal designed for use with the NTT DOCOMO in-home WLAN service. It incorporates technology that guarantees secure communication over the vulnerable Internet link as well as providing 11a functions that expand the construction of environments for internal communication. In future work, we will continue to develop mobile terminals for extensive development of mass markets.

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[6] B. Yamauchi, et. al: "The Home U Service System," NTT DOCOMO Technical Journal, Vol. 10, No. 3, pp. 4-11, Dec. 2008.

*13 **MESSAGE method**: An SIP method used when sending text data to another person, such as in instant messaging.