

Printing Solutions for Era of Ubiquitous Networks

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Connections to networks will become available anywhere at any time as the advent of a ubiquitous era is at hand. Printers in this era will no longer be limited to their existing role of only providing a printing function, but functions that enable the printing of particular data from a whole range of data as the needs arise will be required. Therefore, it is necessary to enable printers to extract the necessary data from multiple applications in order to realize speedy document processing using data available within and outside the company.

Furthermore, a digital multi-functional product (hereinafter referred to as "MFP") equipped with a scanner will not only print documents but also convert scanned image data into a file format, such as PDF or TIFF and send them by email, providing document solutions in collaboration with other applications.

We at Oki Data Corporation have succeeded in commercializing color printers and MFPs that use tandem engines. These are implemented in general office environments where they are widely used as shared printers or MFPs in network environments, color printing of various documents as well as securing a position as document portals¹⁾.

Printers and MFPs are expected to fill the role of not only "peripheral devices for printing" but also "simple to operate data processing equipment for a wide range of uses".

This paper introduces printing solutions for ubiquitous networks, a network technology of the printer with built in wireless LAN (IEEE 802.11b/g) functions, as well as an automatic network connecting technology.

Ubiquitous Printing Solutions

Security will be a strongly demanded issue once printers and MFPs assume a central existence in the data solutions of enterprises. Domestically in Japan, there is also a need to comply with the Act on the Protection of Personal Information that was put into effect in April 2004. Authentication functions to limit users as well as encryption functions for printing data in particular are becoming vital.

In order to provide our customers with printing solutions for the era of ubiquitous networks we at Oki Data Corporation are providing functions that prevent the leaking of information as well as a variety of functions that support a wide range of document applications.

The main solution functions incorporated into our printers and MFPs are introduced below.

(1) Encrypted Communication Function

Wiretapping and tampering from external sources are prevented with the adoption of the SSL/TLS (Secure Socket Layer / Transport Layer Security) technologies and by implementing encryption for communication pathways between printers and personal computers. The transmission of data to printers and remote operations for printer configurations can be conducted in a secure manner. Highly reliable business operations can be promoted particularly for enterprises that handle a large number of personal information by implementing encryption for printing data and obtaining authentication by third-party organizations as part of their security enhancement (Figure 1).

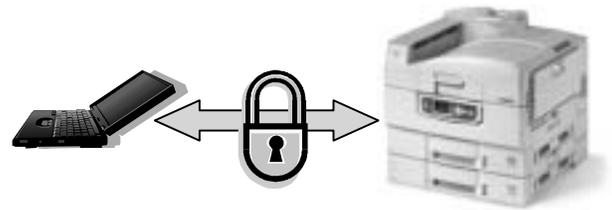


Fig. 1 Preventing wiretaps and tampering with encrypted communications

(2) Secure Printing Function

Whenever confidential documents are to be printed the individual person printing such documents must go to the printer and have his or her identity verified before printing is permitted. With this procedure there are no concerns regarding the printed documents being seen by other people.

The use of IC cards and biometric authentication are being considered as a means of individual identification.

(3) PDF Direct Printing Function

Sending data in the PDF format directly to a printer or an MFP without booting an application is possible. With this simple to use function multiple PDF files can also be printed.

(4) Network Scanner Function

This function delivers images read by a scanner to the personal computer of a user via a network. A diverse range of methods can be used for delivering these images to accommodate the convenience of users, such as using email, storing them in a shared folder or placing them on a web server, etc.

(5) Web Sukkiri (Tidy) Print

On occasions the right side of the page is cut off when a web page is printed. The Web Sukkiri Print utility has a function to automatically adjust the scaling of printing to ensure that the right side of the page is not cut off, thereby eliminating the incomplete printing of web pages.

(6) Managing with Web Browsers

A web server function is incorporated to make it possible to configure and manage equipment using web browsers. Equipment can be managed with graphical interfaces that are easy to follow and use without the need to install dedicated utilities.

(7) Network Management Function

A variety of network support functions are provided, which respond to various needs, such as a function that makes it possible for a person to verify the status of a printer without leaving their seat or a function that sends out a notification automatically when a failure occurs.

Furthermore, integrated management of multiple printers and MFPs on the network is possible using a management utility for network.

(8) Wireless LAN Support

It is possible to have a more flexible selection of installation locations for printers and MFPs on a wireless LAN because there is no need to consider wiring.

It is for this reason that such networks are expected to play a vital role in the era of ubiquitous networks.

(9) Automatic Network Connection

Connections to printers and MFPs are established automatically simply by connecting to the network. All the complex configuration operations that need to be done prior to printing are eliminated and connections to printers and MFPs can be established very simply whenever needed.

Descriptions on technologies relating to wireless LAN that realize the “anywhere” component as well as technologies relating to automatic network connections that realize the “any time” component as vital technologies required for printing solutions in the era of ubiquitous networks will be provided in subsequent sections.

Wireless LAN Technologies Surrounding Printers and MFPs

The main methodologies of the wireless communication technologies that can be applied to printers and MFPs are introduced before our wireless LAN solutions.

(1) IEEE 802.11

This is the communication standard which is commonly referred to as “Wireless LAN”. At the present time this is the most pervasive wireless communication technology incorporated into printers and MFPs.

The current standard provides for three methods (802.11b, 802.11g and 802.11a) that are all different in

terms of frequency and modulation method²⁾. Although the communication speed is stipulated as 54Mbps for the 802.11g and 11a according to the standard, in reality however, the throughput available to users is approximately 22Mbps at best.

The Wi-Fi Alliance³⁾ is an industry organization running a program in which they grant manufacturers the right to use the “Wi-Fi Certified” logo for equipment that have passed interconnectivity tests. Wireless LAN equipment that has been granted the use of this logo is guaranteed to meet the minimum requirements for interconnectivity.

(2) Security of IEEE 802.11

The WEP (Wired Equivalent Privacy) encryption was initially used as the security standard for the IEEE 802.11⁴⁾. This method involves a common encryption key, which is shared by both the access point and the wireless terminal to encrypt communications. The vulnerability of the WEP method itself became apparent, however, so in order to respond to the situation the Wi-Fi alliance decided to adopt a portion of the wireless LAN security standard known as the IEEE 802.11i that was at the time still being formulated and they standardized it as the “WPA” (Wi-Fi Protected Access) before the formulation of the base standard had been completed. The WPA standard was later revised to be the “WPA2” with the formal establishment of the IEEE 802.11i standard.

Almost all wireless LAN products available on the market today are either WPA or WPA2 compliant and concerns about security that existed when the 802.11b initially became popular have now been almost completely resolved.

(3) Bluetooth

This is a short-range wireless communication standard that is effective up to approximately 10m. Devices can communicate with each other one on one, just as if wireless connections had replaced the connector cables.

Since the transmission rate of this standard is too slow for printer connections we decided not to adopt this standard for our products.

(4) WiMAX (Worldwide Interoperability for Microwave Access)

This wireless communication standard extends the communication range from several kilometers to tens of kilometers. Voice communications using VoIP (Voice over IP) was adopted as well as data communications and it is expected to become a technology that will be competing against mobile phone handsets.

(5) UWB (Ultra Wideband)

This standard is used to conduct high-speed communications using an extremely wide frequency bandwidth of approximately 1GHz. It is expected to become a short-range high-speed wireless communication standard as standardization efforts continue. Although a variety of uses are being considered the application for wireless USB is drawing a lot of attention at this time.

(6) Next-Generation Wireless LAN

● MIMO™ (Multiple Input Multiple Output)

This method developed by Airgo Networks, Inc., of the United States is a high-speed methodology for the IEEE 802.11.

High-speed communications and stability are realized using multiple antennas. Connectivity using conventional 802.11 equipment is also assured. The MIMO technology has been adopted as part of the next-generation wireless LAN standard, the IEEE 802.11n.

● IEEE 802.11n

The IEEE 802.11n is being formulated by the IEEE as the next-generation wireless LAN standard. The 802.11n standard is expected to have a throughput of 100Mbps or more, making available communication speeds that rival those of wired LAN. Compatible products are expected to be available on the market in 2006 around the time the standardization will be completed.

Wireless LAN Solutions from Oki Data Corporation

Oki Data Corporation is undertaking activities to realize wireless LAN solutions with two methods for printers and MFPs.

The first method involves incorporating a built-in wireless LAN board that supports high-speed color printers, which will provide the high communication speeds considered essential for high-speed printers and the high degree of security required of corporate networks.

The other method involves using an externally mounted wireless LAN print server that supports printers with a USB or wired LAN interface.

(1) Internal Wireless LAN Board (Photo 1)



Photo 1 Overview of built-in wireless LAN board

(1) -1 Radio Specifications

The main radio specifications of the built-in wireless LAN board are as follows (Table 1).

Table 1 Radio specifications of wireless LAN board

Standard	IEEE802.11b/g
Connection	Ad-Hoc Infrastructure
Authentication method	WEP shared key authentication WPA-PSK (pre-shared key) 802.1X (EAP-TLS)
Encryption function	WEP64bit/128bit TKIP

This wireless LAN board has the following features.

● High-speed Communications of IEEE 802.11g

Communication speeds required by high-speed color printers have been realized through the adoption of the IEEE 802.11g as the wireless LAN standard for the board.

● Wireless Connection Function Makes Flexible Operating Modes Possible

The board supports both an Ad-Hoc (ad hoc) mode and an Infrastructure mode for the wireless LAN network.

Wireless terminals communicate with each other one on one when the Ad-Hoc mode is in use. Therefore, this mode is suitable for networks of a smaller scale, such as those in a SOHO (small office home office).

The Infrastructure mode, on the other hand, is configured with the wireless terminals connected to the Access Points (AP). Terminals can also communicate with terminals that exist within wired LAN networks via APs. It is for this reason that this mode is suitable for networks in a general office environment.

● Security Function Supporting Corporate Networks

Security for wireless LAN has been standardized as the IEEE 802.11i. Security measures are comprised of authentication and encryption. Descriptions are provided below regarding the IEEE 802.1X, which is the advanced authentication method adopted by the IEEE 802.11i.

Several methods are available for incorporating the IEEE 802.1X, including the "EAP-TLS" (RFC2716)⁵. Electronic certificates are user authenticated with the IEEE 802.1X and, therefore, only successfully authenticated wireless terminals are connected to the network. It is for this reason that a pre-shared key must be configured in both the AP and the printer. Although the security is more robust than the authentication conducted by the WPA-PSK (Pre-Shared Key) authentication advanced technologies are required, such as the management of electronic certificates and operation of the authentication server (RADIUS: Remote Access Dial-In User Service server).

The authentication procedure for a printer using a RADIUS server is shown in Figure 2.

First of all, a wireless connection is established between the printer and the access point (①). Next, the printer conducts mutual authentication with the RADIUS server via the access point (printer and RADIUS server mutually authenticating each other) (②) and access to the network is made available to the printer once the

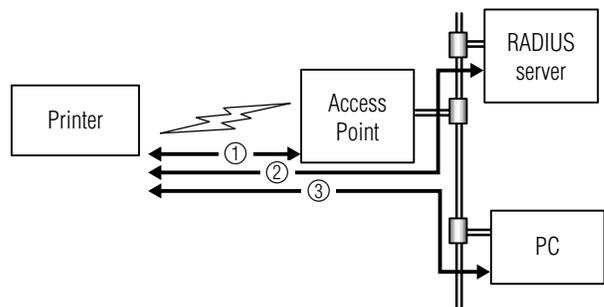


Fig. 2 Wireless authentication by IEEE 802.1X

authentication has been completed successfully, thereby making it possible for the printer to communicate with terminals on the network (③).

(1) -2 Network Specifications

A wired LAN interface and a wireless LAN interface have individual IP addresses as well as other network settings and they can be simultaneously operated in parallel.

By realizing simultaneous parallel operations with the wireless LAN and wired LAN, new solutions are possible that cannot be provided by conventional wireless LAN mounted printers or MFPs, for example, to implement the board in a large-scale office environment wherein wired LAN and wireless LAN coexist.

(2) External Wireless Print Server

External wireless print servers are provided to printers and MFPs that only have a USB or wired LAN interface.

The externally mounted wireless print server has been designed to maintain connectivity compatibility with our printers and MFPs while offering users a functionality and operability equivalent to those of a built-in network interface.

Automatic Network Connection Solution

In order to connect printers and MFPs to networks in the past complex configuration operations were necessary. The simplification of configuration operations is a critical issue for ubiquitous printing. As solutions for automating network settings we offer the following technologies and we are currently engaged in development activities aimed at creating products based on these technologies.

(1) UPnP (Universal Plug and Play)

This is a technical specification developed by Microsoft® Corporation. The purpose for this is to make it possible to establish connections to networks without complex operations or configurations.

A feature of the specification is that once printers and MFPs supporting UPnP are connected to a network they can be detected by personal computers running on Windows operating systems without any special configurations or operations, allowing printing to be executed.

(2) Bonjour (Rendezvous)

Bonjour is an automatic network connection method developed by Apple® Computers (renamed from its former name of "Rendezvous").

It is possible to very easily search, connect and print from printers that are connected to the network from Macintosh® personal computers running on Mac OS X™ operating systems.

(3) BMLinkS[®]

This is a standard specification for OA equipment developed by the Japan Business Machine and Information System Industries Association (JBMA) with the slogan "Connect, Find, Get".

Specifications have been stipulated in three fields of discovery, data format and job/device control.

Personal computers installed with a BMLinkS integrated driver can be connected with any device that supports the BMLinkS standard, regardless of the manufacturer. Devices offering functions desired by the user are detected and office services become available, such as printing.

The major difference between this and standards like UPnP or Bonjour is that this does not just search but the standardization encompasses data formatting as well. A single integrated driver will be able to detect, print and control any model of any manufacturer.

Conclusion

Various printing solutions, wireless LAN technologies and automatic network connection technologies for the era of ubiquitous networks have been described in this paper.

We intend to keep on raising the functionality and lowering the cost of printers and MFPs, while also continuing with our development of printing solutions intended to include systematic elements and not just individual products.

References

- 1) Nakazato et al: "Controller Firmware Technologies for High-Speed Color Printers", Oki Technical Review Issue 194, Vol. 70, No. 2, April 2003.
- 2) Matthew S. Gast: "802.11 Wireless Networks: The Definitive Guide" Japanese version, O'Reilly Japan, September 2003.
- 3) Wi-Fi Alliance web site: <http://www.wi-fi.org/>.
- 4) Bruce Potter: "802.11 Security" Japanese version, O'Reilly Japan, May 2003.
- 5) Jonathan Hassell: "RADIUS – User Authentication Security Protocol" Japanese version, O'Reilly Japan, December 2003.
- 6) BMLinkS web site: <http://www.jbmia.or.jp/bmlinks/index.htm>.

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