

i-mode Communications Protocols

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The i-mode service enables users to access a wide range of information on the Internet via PDC-P and i-mode servers by operating i-mode mobile phones. This article reviews the network configuration that makes the service work, and the characteristics of i-mode communications protocols.

1. Introduction

i-mode is a service that enables users to access a wide range of information on the Internet by operating i-mode mobile phones, based on Internet connection via the PDC Mobile Packet Data Communication System (PDC-P) and i-mode servers. The i-mode network is based on the DoCoMo network and the Internet. The DoCoMo network adopts special communications protocols that are designed to minimize the overhead and maximize the efficiency of i-mode communication.

This article describes the i-mode system configuration and the protocol stack between the devices, and reviews the behavior of the Transfer Layer (TL) and the Application Layer (AL), which constitute i-mode communications protocols.

2. System Configuration

2.1 System Configuration

i-mode's system is configured with i-mode mobile phones (for displaying and operating content), PDC-P (for establishing i-mode communication within the DoCoMo network), i-mode servers (which serve as gateways between the DoCoMo network and the Internet) and information providers (who provide various types of contents).

2.2 Communications Protocols

Figure 1 illustrates the protocol stack of i-mode.

Between the i-mode mobile phones and the Mobile Message-Packet Gateway Module (M-PGW), the TL protocol

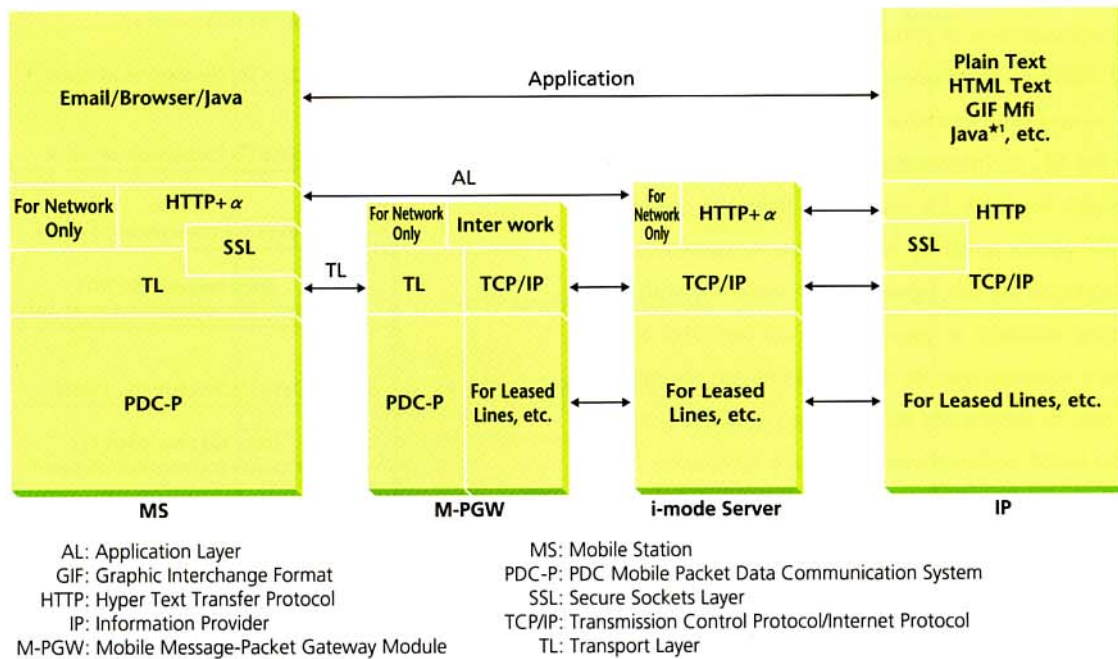


Figure 1 i-mode Protocol Stack

in the Transport Layer is used for the transmission/reception of data, in order to minimize the number of signals for efficient data forwarding. Between the M-PGW and the i-mode servers, general-purpose protocol Transmission Control Protocol (TCP) is used for the transmission/reception of data, as the M-PGW has the function to ensure interoperability between TL and TCP by converting TL into TCP. Between the i-mode mobile phones and the i-mode servers, the AL protocol is used for processing the transmission/reception of messages and the acquisition of content data.

3. Overview of Communications Protocols

3.1 TL

(1) Overview of Functions

TL is a protocol defined in the transport layer between the mobile phones and the M-PGW. It was developed to transmit/receive relatively small Hyper Text Markup Language (HTML) files that are unique to the i-mode service. Compared to TCP, TL has limited functions and applications, as it was designed in consideration of communications systems exclusive to mobile communications. The merits of TL are the simpler control signals and the smaller overhead than TCP. TL has the following key features.

① Error Detection

TL can detect errors by checksum.

② Response Confirmation

TL checks whether the sent data has been properly transmitted/received between the mobile phones and the M-PGW by referring to the data response signal. It also checks whether the connection has been established by referring to the response signal to the established connection.

③ Data Piggybacking

For efficient data communication, TL reduces the number of signals in the network by allowing control signals to piggyback data. M-PGW allows multiple packets of data received from the server to queue up until they can be put together into one big chunk.

(2) TL Communication Behavior

① Connection-based Communication

The mobile phone sends an Open Request and starts establishing the connection. This signal sets the parameter values (retransmission frequency, timer value, data size, etc.) that are acceptable to the handset. The connection is established and the parameters are decided when an Open Acknowledge is received from the network. The connection is activated according to the set values.

Once the connection is established, data is trans-

★1 Java: An object-oriented programming language suited for use on networks, developed and advocated by Sun Microsystems in the U.S.

mited/received. When the forwarding of the data is completed, the connection is terminated by a Close Request.

Figure 2 illustrates the sequence.

② Connectionless Communication

From the AL, an Information signal is sent to the i-mode mobile phone to notify the user of an incoming message. The mobile phone sends an Information Acknowledge in response to receiving this signal. As the signal for notifying an incoming message is generated on an irregular basis, every time a message reaches the i-mode server, the mobile phone is able to receive the Information signal even during connection-based communication. **Figure 3** illustrates the sequence.

(3) 503i Functions

The 503i Series has the following functions for achieving efficient data forwarding, to handle increased trans-

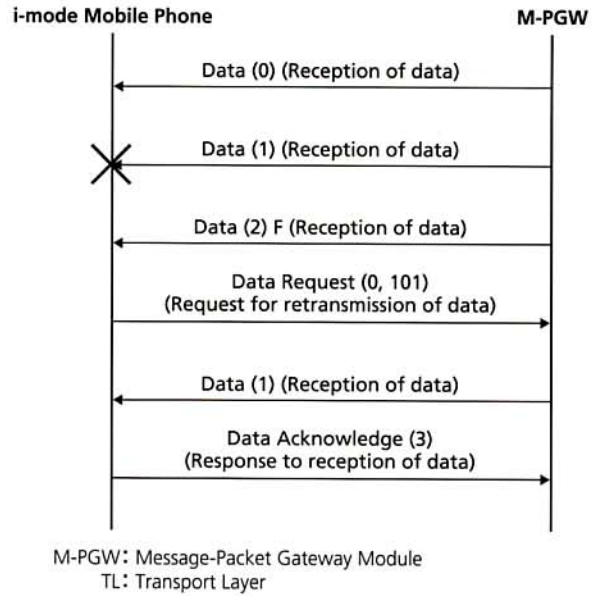


Figure 4 TL Retransmission Sequence

mission/reception of content data.

① Window Size Control

In conventional handsets, the response had been confirmed for each packet of data that was transmitted/received. In the 503i series, the response is confirmed for multiple packets of data at once, in order to improve the transmission efficiency.

② Retransmission Control

An efficient data retransmission method is required to deal with data that goes missing during transmission/reception, which is likely to happen at wireless sections and during window size control. The following is an example of how the 503i series tackles this situation.

- Actions taken if data goes missing during forwarding:

The receiving side determines that the data is missing as soon as it has received the data, and sends a data request to the transmitting side, which is a request for the missing data. The transmitting side sends the missing portion of the data after receiving this signal. **Figure 4** shows the sequence.

3.2 AL

(1) Overview of Functions

AL is a protocol specified to enable services between the i-mode mobile phones and Information Provider (IP) servers, as well as the i-mode servers. The protocol is adapted to both push- and pull-type communication. In pull-type communication, the browser on the i-mode mobile phone acquires content

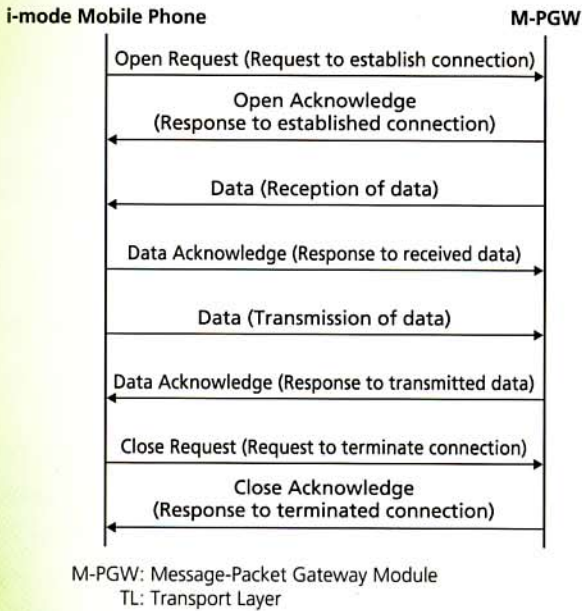


Figure 2 TL Connection-based Communication Sequence

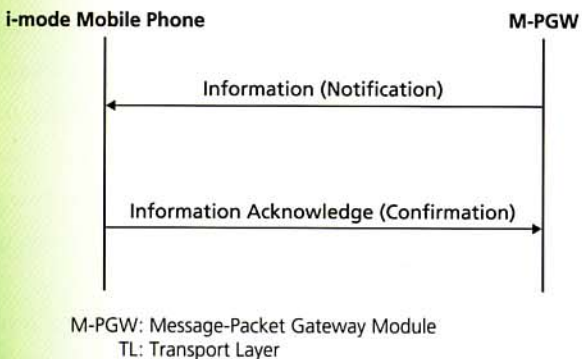


Figure 3 TL Connectionless Communication Sequence

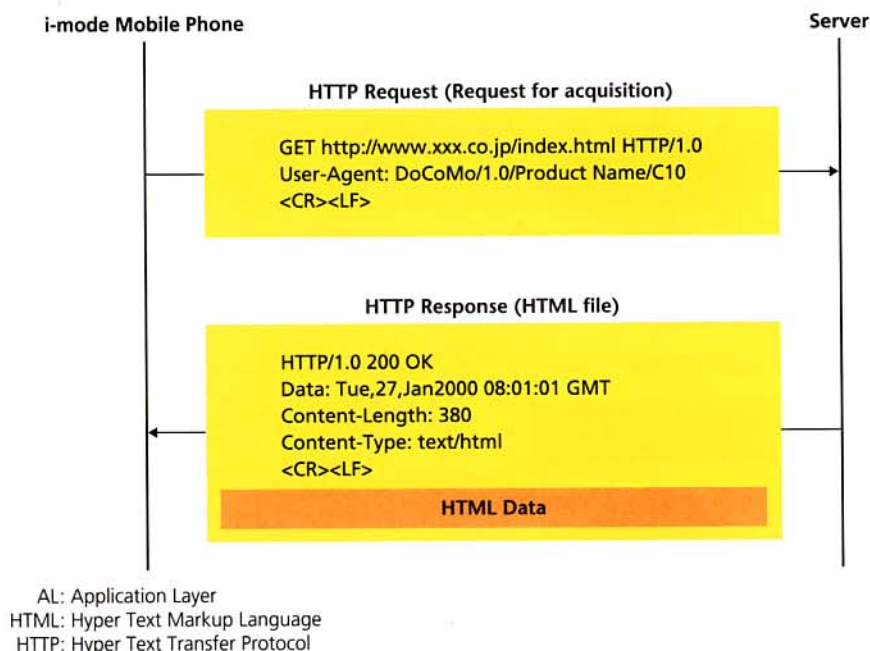


Figure 5 AL Pull-type Communication Sequence

data from the IP server through the Hyper Text Transfer Protocol (HTTP), which is a standard protocol on the Internet. In contrast, push-type communication is equivalent to the transmission/reception of e-mail by specifying an extended header in HTTP format. The characteristics of the AL protocol are as described below.

① Incoming Message Notification Function

When an i-mode server receives an e-mail, the i-mode mobile phone is informed of the reception.

② Reduced Number of Signals

E-mail is in HTTP format, which requires a smaller number of signals than the Post Office Protocol (POP) and the Simple Mail Transfer Protocol (SMTP), which are commonly used.

③ Reduced Data Volume

The data volume is reduced by not attaching any HTTP headers that are unnecessary for the service.

(2) Basic Behavior of HTTP

HTTP is a simple protocol based on request and response. It acquires information based on requests from mobile phones and responses from servers (IP server or i-mode server). The request is sent with regard to the method, the Uniform Resource Identifier (URI), the protocol version and the message, whereas the response is received with reference to the protocol version, the status code and the status line of the message. AL supports GET and POST methods and version HTTP.1.0.

(3) AL Communication Behavior

① Pull Function

The user operates the browser and sends an HTTP request signal to the server by choosing a link or by specifying the URL. The information is displayed after receiving the HTTP response signal from the server. **Figure 5** illustrates an example of a mobile phone which is “pulling” information from the server.

② Push Function

The mobile phone receives an incoming message notification signal from the i-mode server when an e-mail, message free or message request reaches the server. When the mobile phone receives such a signal, it checks whether there is enough space for storing messages; if there is, it uses the pull function for receiving the HTTP request and response, and thereby receives the message.

For the reception of e-mail, the mobile phone can determine whether there are any subsequent messages by referring to the header of the HTTP response. It can therefore automatically acquire e-mail if there are any in the server. **Figure 6** shows the sequence.

(4) Functions of the 503i Series

The 503i Series supports SSL^{*2} communication.

In SSL communication, the i-mode mobile phone sends a

*2 SSL: Secure Sockets Layer, a protocol that creates a secure connection between a client and a server, developed and advocated by Netscape Communications in the U.S.

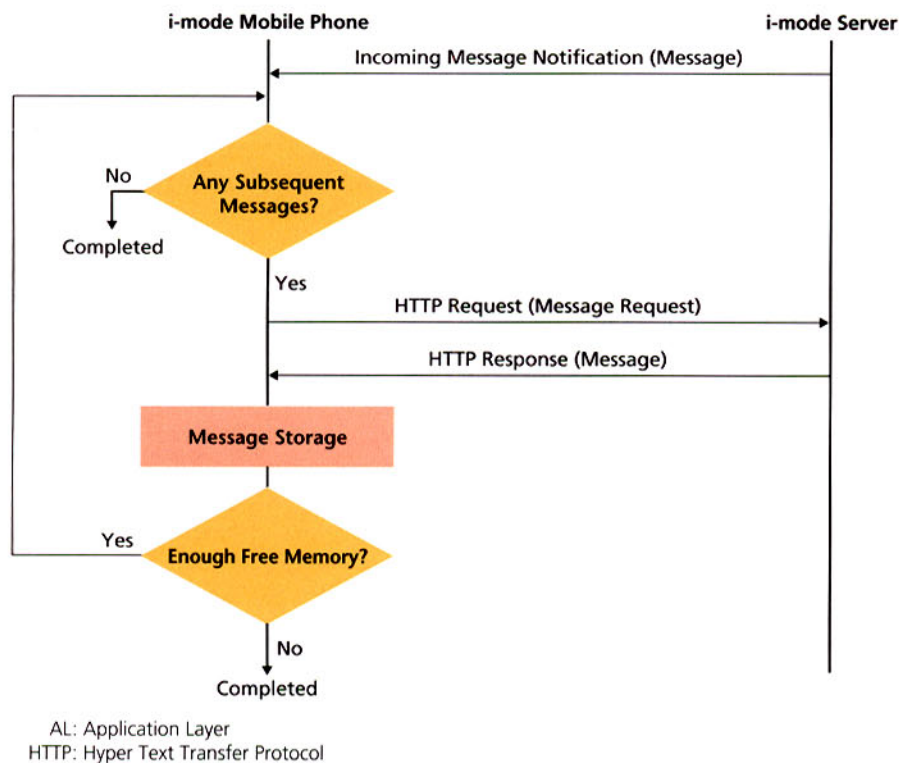


Figure 6 AL Push-type Communication Sequence

tunneling request to the i-mode server, which, in response, determines whether it should establish SSL communication between the content server and the mobile phone (e-SSL) or between the content server and the i-mode server (s-SSL). It then sends a specified status code to the i-mode mobile phone. For e-SSL communication, the i-mode mobile phone establishes everlasting communication with the CP server by setting Keep-alive with respect to the HTTP request.

4. Conclusion

This article described the network configuration that makes the i-mode service work, in addition to the TL and AL proto-

cols, which are used as i-mode communication protocols.

Content for the i-mode service is expected to diversify in the years to come. Our next challenge is to further improve the efficiency of data communication and the quality of the service.

REFERENCES

- [1] K.Chiba, et al: Special Article on i-mode Services, Digital Mova powered with Micro-browser, New Technology Report, Vol.1, No.1, pp.26-35, Oct.1999.
- [2] M.Hanaoka et al: Special Article on i-mode Services, Network Technologies, New Technology Report, Vol.1, No.1, pp.14-19, Oct.1999.

GLOSSARY

- AL: Application Layer
- BS: Base Station
- GIF: Graphic Interchange Format
- HTML: Hyper Text Markup Language
- HTTP: Hyper Text Transfer Protocol
- IP: Information Provider
- M-PGW: Mobile Message-Packet Gateway Module
- MS: Mobile Station
- PDC-P: PDC Mobile Packet Data Communication System
- POP: Post Office Protocol
- SMTP: Simple Mail Transfer Protocol
- SSL: Secure Sockets Layer
- TCP/IP: Transmission Control Protocol/Internet Protocol
- TL: Transport Layer
- URI: Uniform Resource Identifier