Ship-to-Shore E-mail Communications for Mariners by Internet Standards and Technology

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Abstract - There are some shipboard E-mail Internet gateways or servers on the market which of course can be used for ordinary ship-to-shore communications, such as telex or telefax. However, this does not seem to be enough for merchant ships as general E-mail communications because a special E-mail address or a special server with administration must be used, not a standard communications protocol. This paper describes a system for mariner on merchant ships, designed and tested by the authors. The system has also been made and installed for ordinary E-mail communications from an ocean-going vessel by satellite and maritime telephony with modem.

I. Introduction

In shipping companies, electronic mail (E-mail) is in general use. Some companies use E-mail between their headquarters and the ships. An on-board communication server (including E-mail) must be secure and cost effective. It is appropriate to use this type of communications with head-quarters also for ordinary ship operations. The mail server of this type is often configured according to special specifications. It is therefore difficult for such a specially designed system to communicate via the Internet. On the other hand, people usually communicate by Internet standards on shore. In this paper, we describe the design of an E-mail server for the above applications using Internet standards, simulations according to these specifications and installation on board a ship.

II. E-mail Operations Program

E-mail communications systems consist of some well-known Internet standard programs. These programs are Sendmail as an ordinary Mail Transfer Agent (MTA), UNIX to UNIX CoPy (UUCP) and some gateways. Sendmail is used on many E-mail servers as MTA and standard program on UNIX. This program has functions not only for mail transfer but also many functions for the rejection of illegal E-mail connections. Sendmail also has other mail transfer functions like transferring priority, restricting delivery, receiving mail by one connection only etc. The program also delivers information such as E-mail size, address, recipient etc. UUCP is also a standard program on UNIX [1] that is used for standard mail transfer by means of a modem. UUCP protocols are non-interactive and limited, and therefore UUCP is suitable for on-board use and security.

A. E-mail security for merchant ships

Generally, there is almost no user charge for transfer of own mail by the Internet. However, on a merchant ship a so-called “thin” line is used, and personal mail may be charged by volume or time. An important problem is unwanted E-mail messages between shore and ship. Examples of such unwanted messages are mail bombs, camouflaged mail, junk mail etc.[2]. These problems are mainly related to mail to the ship, not from the ship. In order to avoid such unwanted mail, the mail server at shore must have a sufficient gateway function. The concept of shore gateway is shown in Figure 1. It is possible to use for E-mail communications by ordinary modems without special lines and equipment. For cost reasons, it is important to build up the system on board. Sendmail functions can use the gateway for on-board and shore as a mail server. The gateway operation of the shore mail server can use the communications standards of the Internet.

III. E-mail server with gateway function

In this paper, the task of a gateway is to restrict and to avoid unimportant and unnecessary E-mail transfer from shore to ship. Gateways for ship and shore differ. The shore gateway is very important for the security of merchant-ship E-mail communications (e.g. to handle limited access). On the other hand, the gateway of a ship needs some function of support for mariners rather than complete
A. Function and policy for shore gateway

Limitation of E-mail transfer from shore to ship is dependent on E-mail communications policy and the performance of the communication line. To avoid line occupation, the E-mail server (including the gateway) must be able to control size and volume depending on the capacity of the communication line. We considered some different kinds of policy on E-mail communications shore to ship. As an example, assuming that the available time for E-mail transfer to an on-board phone is 5 minutes and the bit rate is 9600 b/s, about 300 Kbytes of E-mail can be transferred from shore to ship (except negotiation time). Therefore, the mail gateway must restrict or reject messages over this size before sending E-mail to ships.

B. Ship gateway function

The security on board is always kept at a high level because almost every mariner knows very well that all communication lines are expensive and important for the operation of the ship and there are few people on board. Therefore, it is not very probable that mariners send mail of considerable size from a ship. However, in order to avoid transmission of "wrong" mail, it is necessary for a ship to have an E-mail minimizing gateway.

IV. Minimizing administration on board by address alias

Generally, mariners (including officers) dislike new systems, even navigational equipment. Therefore shipboard administration and management for all systems must be kept at a minimum. Management of E-mail may be a big problem, implying addition of new accounts, deletion and movements. However, the management method can change some configurations in headquarters on shore by the method below. In order to decrease management on board, it is possible to build standard programs on UNIX OS and simple scripts into gateway. The proposed "using alias mail address" concept is described in the following. The E-mail server uses Sendmail as the basic component for a mail server. Every mariner has an E-mail address with his personal name, e.g. "Captain Absent" uses "absent@shipping.com" as his E-mail address. However, all on-board mail servers do not have these personal-name E-mail addresses, they only have titles as E-mail addresses. When "Captain Absent" is on board, he receives the E-mail of the master of the "M/V October goes" using "master@oct.shipping.com" as his E-mail address. If he wants to send E-mail, however, he uses his personal-name E-mail address. For security reasons, the domain name and E-mail address of the ship are not open.

A title-name E-mail address is not open to a customer or to her/his family, but this address can be used inside the shipping company and on the ship itself. The reason for this is the wish to avoid unnecessary E-mail connections and make on-board management a minimum. The facility of E-mail address change from a personal name to a title/name is provided by the alias function in Sendmail[3]. The alias function converts E-mail addresses on alias maps. As an example, absent@shipping.com is converted into master@oct.shipping.com on the alias map of the shore mail server. In case the master of the "M/V October goes" wants to move to another vessel to be master of the "M/V November goes", the administrators of his headquarters only change part of the Sendmail alias map. According to this method, it is possible to communicate by only one E-mail address to each person even if he moves to another ship. It is also not necessary to change the configuration file onboard. This E-mail address handling facilitates management because most mariners change ships approximately every 10 to 12 months. The personnel transfer is determined by headquarters. There must be at least one system administrator for E-mail communications to change alias maps.

A. Gateway action against illegal mail

An E-mail server consists Sendmail and a gateway. Sendmail can work for delivery and reception address checking, and for E-mail address alias. After an alias of the E-mail address in the on-shore E-mail server has been made, the E-mail is sent to the gateway by the Sendmail facility. This type of E-mail for ships is checked by the gateway program. This gateway program has some functions for checking address, value, size and header (cut-add). If the program receives unwanted mail, it can choose to return this mail to the sender, to ignore it or to forward it to other people on shore. In case of received E-mail with pre-registered E-mail address, the E-mail can not be delivered to a registered E-mail with ship address. Junk or
bomb E-mail envelope addresses are characterized by "doubtful" names. The program reads the pre-registered list of junk mail addresses, rejects E-mail that has "doubtful" sender addresses (e.g. nobody, to-sir, catalogue etc.). In case of acceptable E-mail, this gateway program cuts the header depending on the gateway function. As an example, a "Received:" header is trimmed by the gateway, because in case of short mail, a "Received:" header is generally longer than the body. The "Received:" header in E-mail is added automatically to the end of the list itself. Therefore, in case of small-size mail, this part is bigger than the mail body. The advantage of this function is that it reduces volume by header cut. Checked and cut E-mail with additional header is sent to a ship by UUCP. UUCP is run at regular intervals (hours or days). The interval of UUCP communications from shore to ship is determined depending on bandwidth, bit rate, costs, priority and value of file transfer.

B. Rejection rule based on E-mail address

The address of the sender in case of junk or bomb E-mail (envelope address) is almost always a "doubtful" name. The program rejects E-mail that has a "doubtful" address or envelope (e.g. nobody, to-sir, catalogue etc.). The gateway program always reads the file of every E-mail recipient at reception from outside the company. If it receives huge or otherwise unacceptable E-mail, this E-mail is returned to the original sender address by this gateway. Furthermore, E-mail with a title address of a mariner coming from outside the company is rejected or returned by this gateway, because such mail may be junk mail. E-mail with real name addresses from inside the shipping company is not rejected, because inside mail does not use this gateway, and in many cases there are messages for each class of persons on each vessel.

C. Gateway test on Internet

These proposed gateway functions were tested on an ordinary Internet E-mail server at the Laboratory of Communications Engineering, Tokyo University of Mercantile Marine. In this simulation, the communication line used the Internet, not a modem. As ship server, we used the same Internet mail server on UNIX at Toba National College of Maritime Technology. The distance between the two sites is about 200 km. The network delay is usually about 300 ms by Ping\(^1\). The tested E-mail domain at TUMM has 20 users of E-mail and transfers (sent and received) approximately 2 Mbytes a day. In this simulation, the mail transfer value decreased 5% by header cut. 10 transfers (approximately 50 Kbytes) of unwanted mail were rejected by the proposed gateway.

V. E-mail application for use on board merchant ships

Figure 2 shows the block diagram of the position reporting system of a ship. This server is connected to navigational equipment as a gyro compass and a GPS receiver via RS232C. The system has a position reporting program by E-mail and telephone lines. The server provides E-mail transfer and connection between the ship and the outside world by Sendmail and UUCP. This server was installed on the training ship HOKUTO MARU (length 125 m, 5877 tons), that belongs to the Institute for Sea Training, Ministry of Transport, Japan. The communications performance was measured during voyages in the Pacific and Indian Oceans. The lines used are telephone by INMARSAT-B voice line and coastal maritime telephone (250 MHz band, analog FM).

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\(^1\)Ping is a program on UNIX and Windows95, used for network testing.
Table 1: Protocol versus information transfer speed.

<table>
<thead>
<tr>
<th>Lines</th>
<th>Protocols</th>
<th>byte/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal telephone</td>
<td>V22bis+V42bis UUCP g</td>
<td>273</td>
</tr>
<tr>
<td>INMARSAT-B</td>
<td>V22+UUCP i (*1)</td>
<td>66</td>
</tr>
<tr>
<td>INMARSAT-B</td>
<td>V22+UUCP g</td>
<td>77</td>
</tr>
<tr>
<td>INMARSAT-B</td>
<td>V22+V42+UUCP g</td>
<td>100</td>
</tr>
<tr>
<td>INMARSAT-B</td>
<td>V22+V42+UUCP i</td>
<td>112</td>
</tr>
<tr>
<td>INMARSAT-B</td>
<td>V22+V42bis+UUCP g</td>
<td>123</td>
</tr>
</tbody>
</table>

Notes: (*1) All UUCP data packets sizes are 64 bytes. V22 means ITU-T V.22, 1200 bit/s. V22bis means 2400 bit/s. V42bis means error correction and data compression.

only E-mail for ship service but also correspondence. The total number of users was 10 (including officers, cadets and researchers). The ordinary modem connection worked well on board without any modem negotiation error. According to the UUCP connection logs, there was no communication error on the UUCP protocol, however there were 11 modem negotiation failures between shore and ship during this voyage.

Table 1 shows UUCP communications performance on each line using protocols by modem and marine telephone. The values shown are average values from a voyage of 45 days from Tokyo. Connection UUCP protocols were of different kinds, this experimental server used "i" and "g" protocols. The "g" protocol is very simple, it has a 60-byte data packet and ACK and NACK packets. The "i" protocol is more effective and has full duplex communications, variable size of data packets and windows. Performance depends on protocols and line. The "g" is a better protocol than the "i" in this experiment. Long packets of the "i" protocol may not be good for the delay and the voice codec. The best way to decrease connection time is a short data sequence because INMARSAT-B voice line users are charged in accordance with the time used. Modems usually need negotiation time, but this time is independent of transfer volume. Figure 3 shows connection time versus transfer speed for each UUCP connection. This value also depends on protocol, modem and line. In this case, cost-effective communications by modem is achieved when the data transfer includes more than approximately 600 bytes. The UUCP connection method needs a modem and an ordinary maritime telephone. It is available for E-mail system installation on almost all merchant ships.

B. Position report by E-mail with new header

Generally, an E-mail program displays the time when the user (Mailer) wrote the E-mail message. The time is often changed from original time (sender’s local time) into recipient’s local time by the Mailer. However, ocean-going vessels may change time zones every day, which may confuse E-mail users on land. Such confusion can be reduced by the proposed mail header. This function is very simple, and can be run on every UNIX machine. The header uses Internet standard rules, RFC 822[4]. It is also possible to use rules for ordinary E-mail relay and transfer to the Internet. Figure 4 shows the position of the ship as reported by E-mail. This mail was written by the proposed mail header and automatically generated by the server. This proposed header includes three time zones: Universal Time (UT), Ship’s Apparent Time (SAT) and the time zone of reception. This header is added automatically to each E-mail. If the position of the ship is also added as this X-header (X-Position: [latitude] [longitude] or X-Location: [name of port] etc.), every mariner does not always note his own position in the body of the mail.

Pretended or camouflaged mail creates serious problems. For user authentication, PGP (Pretty Good Privacy)[5] can be used efficiently. The gateway may adds a serial number, this is to avoid camouflaged mail by bellow header X-GW-SN: [serial number], X-Signature: [electric signature].

2SAT means Ship’s local time
C. Web-based ship E-mail program with header customization

As an example of the mail header methods mentioned above, Figure 5 shows an on-board mail program (Mailer) using World Wide Web (WWW) technology. A mariner can send E-mail by this program everywhere inside his ship by a Local Area Network (LAN), (including radio LAN). The program consists of a WWW browser and a common gateway Interface (CGI)[6]. The software adds the time zone of the recipient and position information of the ship to ordinary E-mail. The time zone selection function is available for manual operation by the mariner.

VI. Conclusions

In this paper, we have described an E-mail communications system for merchant ships, designed and tested by ourselves. We have also installed, tested and used E-mail communications from an ocean-going vessel using satellite and maritime telephony with a modem and standard E-mail communications tools without special software. The E-mail gateway for ship to shore now works almost completely for E-mail transfer. The proposed E-mail server (including the gateway function) for ship and shore communications is very simple, and it is free. The mentioned E-mail system provides cheaper information exchange than telefax, the cost is 1 US$ per 1 Kbytes. It is possible and efficient to use it for almost every mail server based on UNIX.

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REFERENCES