
Chapter 15. The Internet as a Message-Handling Network

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Introduction to The Internet as a Message-Handling Network

Context

This chapter depends, in particular, on the content of chapters 8, 9 and 13 in developing a view of the Internet as a message-handling network.

Introduction

The coding capability described in chapter 6, and the fabric for the exchange of data established in the previous units, can be combined to create a message exchange capability. Message exchange can be conceptualised as the exchange of message files or as the streaming of coded messages across the network. E-mail can then be seen as a formalised way of exchanging text composed of alphanumeric symbols.

The uses of e-mail are considered and elaborated under the broad headings, distinguished by Stefik, of: direct personal communication, group communication, collecting the overall knowledge of a group, and providing widespread access to knowledge and expertise.

The operation of e-mail is then described at a technical level sufficient to expose the way that standard operation is imposed. It also explains the role of e-mail addresses, IP addresses, address resolution, mailboxes, mail submission servers and mail servers generally.

Objectives

At the end of this module, you should be able to:

- analyse e-mail in terms of both conceptual issues and implementation issues;
- explain how message exchange is constructed by extending an existing data exchange capability;
- discuss the broad uses of e-mail;
- explain the technical issues involved in e-mail operation.

Content

In parallel with this unit, you should read relevant sections of your textbooks.

Introduction

Given the ability to exchange data over a network, it is not a large step conceptually to creating a message exchange capability and, from this to develop, as e-mail, an electronic version of the ordinary mail.

We have already seen that the precursor of the Internet, the ARPANET, came to be used more as an e-mail network than for its intended usage. Although the ARPANET's widespread community of users did share the expensive computing resources that became available, they evidently found it even more valuable to communicate with each other to cement their widespread community. This unit also explores some of the ways in which e-mail has been used that go beyond direct analogues of those of conventional mail.

In addition, some of the details of the technical operation of e-mail are elaborated.

From data exchange to message exchange

Given an existing data communications fabric, the key to constructing a message communications capability is to have a way of converting the characters that comprise messages to data. We have already seen that there are codes, such as the ASCII code, that allow the text of a message to be converted to data by providing a code for the complete set of characters. In this way, a message composed at a networked computer may be coded by the computer and then transmitted in the same way as any other data. The data may be stored in a file at the sending computer and sent to another computer in what is essentially a file transfer. Alternatively, once a path between two computers (a physical or virtual circuit) has been established, the characters may be sent as they are typed to provide a 'chat' capability.

This explanation also shows that it is important for the computers involved in the exchange to agree about the precise code they will use to represent characters. On the Internet, all e-mails are exchanged using ASCII code, and this provides what can be seen as a 'network code' for the exchange of e-mail. No matter what their native code, all e-mail programs ensure that the text is represented by ASCII codes prior to transmission, so that any computer receiving an e-mail is presented with a sequence of ASCII-coded characters. The sending computer and the receiving computer can convert the ASCII codes to some other code if that is necessary for their normal mode of working. The idea of agreeing on a 'network representation' for everything that is moved across the network regardless of any attribute of the computers involved in the exchange is basic to ensuring uniformity. In the O.S.I. scheme of

things ensuring uniformity is the responsibility of the Presentation layer. Since the Internet lacks this layer, the responsibility has to be devolved to the applications themselves.

This simple conceptual explanation of e-mail underlines its categorisation as computer-mediated communication. It also explains why it is straightforward to include attachments with e-mail messages. The file containing the e-mail and those containing the attachments can be concatenated to form a single larger file which itself can be transferred from sender to receiver.

To Do

Do Review Question 1.

The uses of e-mail

The uses of e-mail on the Internet, as described in Part 2 of Stefik's 'Internet Dreams' include the following:

- direct personal communication,
- group communication,
- collecting the overall knowledge of a disparate group, and
- providing widespread access to knowledge and expertise.

These uses can be considered in turn. While doing so, it is interesting to see how, in different ways, they are valuable for social purposes, or for business and organisational purposes, or for both.

The value of direct personal communication is so obvious as to need little elaboration here. It is valuable for social reasons, allowing for a form of communication in which sender and recipient can both participate at any time that suits them. The advent of Web-based e-mail services such as Hotmail has allowed this form of communication to take place on a global scale. When used for direct personal communication in businesses and organisations, the speed and convenience of e-mail can be harnessed to enhance and facilitate the carrying out of activities in ways that will be considered in the following two units. The benefits of the increased speed and convenience of e-mail when compared to, say, paper-based mail, are not always easy to appreciate without experience, but are something that users of e-mail learn to reap, and often in quite unexpected ways.

To Do

Carry out Activity 1.

Group communication is easily done with e-mail by making use of a circulation list. This brings a considerable increase in convenience over anything that is possible with paper-based methods of communication simply because of the ease of electronic copying when compared to the copying papers. Group communication with e-mail in a social context inevitably loses some of the impact it generates when used for direct communication. It comes into its own in a business context, however, when it can be used for such purposes as providing the means of communication for a group that has been established to carry out a specific project. Because the members of the group do not need to be located in the same place, this style of communication also gives an organisation taking advantage of it considerable flexibility.

E-mail has been used successfully to collect the overall knowledge of a disparate group. The previous paragraph gives a clue to one way in which the context for this situation might be established. When an organisation needs a group to carry a project, the possibility of using e-mail with a circulation list allows it to draw on people from widespread locations. The members of this group, because they are geographically dispersed, are likely to be disparate as well. The overall knowledge of this group on some specific topic is not at all easy to collect. It is possible to take some conventional action, such as calling everyone concerned to a meeting in some specific place, but this runs counter to the rationale for operating a group in this fashion in the first place. The knowledge may be collected, though, by

inviting the members of the group to send their contributions by e-mail. Regardless of its effectiveness, this course of action not only provides a way of proceeding that is appropriate to the circumstances, but also takes advantage of e-mail to provide a solution. In fact, this way of collecting the knowledge of a group can be more effective than others, such as face-to-face discussions. The reasons for this are discussed in the following two units.

To Do

Carry out Activity 2.

Lastly, e-mail is clearly capable of providing widespread access to knowledge and expertise, as long as the possessors of that knowledge and expertise are willing to dispense it, and their e-mail addresses are widely available so that they can be contacted. These circumstances can be enabled and encouraged, perhaps by establishing some standard for recompensing the possessors of knowledge and expertise, and by publishing a directory of the e-mail addresses of such people. The benefits of doing this, both social and within organisations, are not hard to imagine.

To Do

Do Review Question 2.

Now read Part 2 of Stefik, not only to elaborate on the material of this section but also in preparation for the next two units.

The technical operation of e-mail

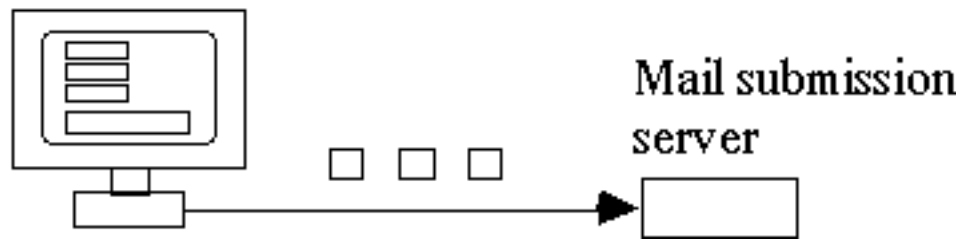
A more-detailed technical view of e-mail than that given in Unit 10 is now presented. It follows the same sequence of events and pattern of explanation as Unit 10.

1. In essence, an e-mail is composed by completing a form, the basic elements of which are:

To:	<input type="text"/>
cc:	<input type="text"/>
Subject:	<input type="text"/>
Message:	<input type="text"/>

The sending computer is set up to communicate with its mail submission server. It treats the completed 'form' as a single message, and sends it to the server using the standard form of communication.

Sending computer



2. On receipt of this message, the mail submission server identifies the address of the intended recipient of the e-mail and separates the domain name. That is, it locates the 'To' field in the complete message it received and, since the content of this field takes the form 'mailbox@domain_name', it extracts the 'domain name' part. For example, if the content of the field were 'G.Marshall@mdx.ac.uk', it would extract 'mdx.ac.uk'. Its next task is to convert this symbolic name to an IP address. This process is known as 'address resolution'.

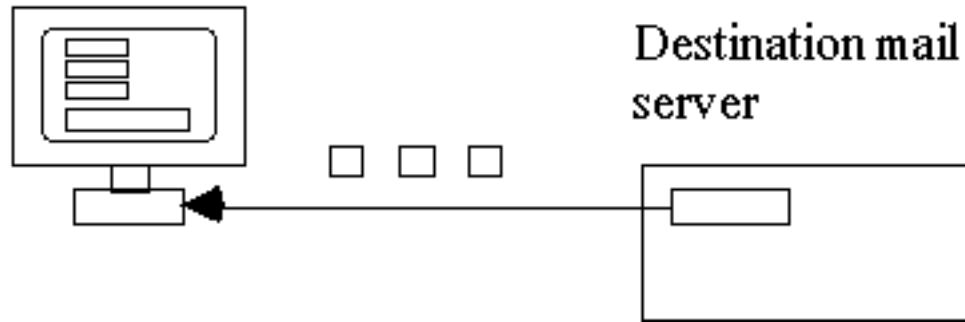
Address resolution is achieved by querying the hierarchy of domain name in the Internet. The following description explains the process for the case of the specific address just given, but it typifies the general process. There is a 'root' server that can be consulted for information on the whereabouts of the server for the '.uk' domain. This name server can be consulted for the location of the '.ac.uk' name server which, in turn, can be interrogated for the location of the 'mdx.ac.uk' name server. Finally, a request to this name server will provide the IP address of the mdx.ac.uk mail server.

The address resolution process can be schematically represented as the following sequence of requests to various servers:

Server	Request
Root name server	Where is .uk name server?
.uk server	Where is .ac.uk name server?
.ac.uk name server	Where is mdx.ac.uk name server?
.mdx.ac.uk name server	What is the address of the mdx.ac.uk mail server?

3. The mail submission server is now in a position to create packets addressed to the destination mail server and submit them to the network. The network routes the packets to the destination mail server.
4. The destination mail server re-assembles the message and, by using the mailbox identifier, places it in the recipient's mailbox.
5. To read any e-mail that has been delivered, the recipient's computer, which is set up to communicate with its mail server, retrieves the items of mail from the mailbox on the server.

Receiving computer



To Do

Do Review Question 3.

Carry out Activity 3.

Activities>

Activity 1 - speed and convenience

How could e-mail show to advantage over otherwise comparable means of communication, such as paper-based mail, simply as a result of its increased speed?

In the same vein, what improvements in convenience can it give over paper-based mail?

You can find a discussion of this activity at the end of the chapter.

Activity 2 - e-mail 'meetings'

We can characterise the activity just described for collecting the combined knowledge of a group on some topic as an e-mail 'meeting'. The purpose of the corresponding face-to-face meeting would be to solicit the contributions of all the members of the group, or to provide the opportunity for a brainstorming session.

Bearing in mind the poverty of the personal interaction that is possible in an e-mail 'meeting' by comparison with what is possible in a face-to-face meeting, can you think of any reasons why an e-mail meeting could possibly be a more successful forum for collecting the combined knowledge of a group than a face-to-face meeting.

[Note that the suggestion is not that e-mail meetings are always better, but that in certain circumstances there is a possibility that an e-mail meeting could be better.]

You can find a discussion of this activity at the end of the chapter.

Activity 3 - exploiting e-mail logs

The following details are taken from the log of an e-mail system. Organise them in such a way that you can identify the groups of people who are in communication with each other about a common interest. For each group you can identify, give the members of the group and their shared interest.

The data is organised so that it is convenient to start with SELF.

It should become apparent that the topics have sub-topics, so that common interests can be identified at different levels of granularity. According to the level of granularity considered, the groups in communication on topics can be divided into corresponding sub-groups.

From: Anne2 To: Mary1 Topic: File transfer

From: Anne3 To: Ken2 Topic: WANs

From: Anne3 To: Len2 Topic: Networks

From: Ben2 To: Jane1 Topic: E-mail

From: Ben2 To: Sonia2 Topic: Network services

From: Bill2 To: Anne1 Topic: Telnet

From: Bill2 To: Anne2 Topic: File transfer

From: Bill5 To: Ben2 Topic: Network services

From: Bill5 To: Bill2 Topic: Network services

From: Hilary1 To: Bill1 Topic: Ethernet

From: Jack2 To: James1 Topic: WWW

From: Jack2 To: John1 Topic: Information networks

From: James1 To: Nancy1 Topic: WWW

From: James1 To: Nancy2 Topic: Browsers

From: Jane1 To: Brian2 Topic: E-mail

From: Jane1 To: Monica1 Topic: E-mail

From: John1 To: John2 Topic: Information networks

From: John1 To: John3 Topic: Search engine

From: John2 To: Mireille1 Topic: Information networks

From: Ken2 To: Hilary2 Topic: WANs

From: Len2 To: Hilary1 Topic: Networks

From: Nancy1 To: Elisabeth2 Topic: WWW

From: SELF To: Anne3 Topic: Networks

From: SELF To: Bill5 Topic: Network services

From: SELF To: Jack2 Topic: Information networks

You can find a discussion of this activity at the end of the chapter.

Review Questions

Review Question 1

Suppose that on a particular network the computers use N different coding schemes. How many code conversions are needed to support transparent communication of e-mail if no 'network code' is agreed.

How many are needed if the ASCII code is agreed as the 'network code' (and ASCII is one of the N codes)?

You can find an answer/comment for this review question at the end of the chapter.

Review Question 2

Name some of the areas in which widespread access to knowledge and expertise would be beneficial, and outline the benefits.

You can find an answer/comment for this review question at the end of the chapter.

Review Question 3

What does it mean to say that a capability such as address resolution is 'provided by the network'? What is the alternative to provision by the network? What are the effects of services being provided by the network and being provided in alternative fashion?

You can find an answer/comment for this review question at the end of the chapter.

Discussion Topics

1. How do we address the problem that occurs in large, open organisations where, because people are so accessible by e-mail, they receive so much of it that it is impossible to read it all, let alone respond to it?
2. The information held in e-mail logs can be used to detect groups of people with a common interest, find people who could benefit from being put in touch with each other because they share a common concern, and so on.

What are the ethical issues associated with doing such things?

Answers and Comments

Activity 1

The speed of e-mail makes obsolete ordinary mail, and any means of communication with similar delivery time, for any application where speed of response is of importance. In fact, e-mail can be fast enough to make possible interaction of the kind that is possible on, say, the telephone but is impossible with ordinary mail.

For anyone already using a computer, it is clearly more convenient to send an e-mail than a paper-based item such as a memo. Because it is electronic, e-mail is self-documenting. The resulting archive is much more convenient to search, either by message or by message content, than any paper-based archive.

Activity 2

Some possible reasons include the following. In face-to-face meetings, certain types of people are at an advantage. They include fast thinkers, who have an advantage over slow thinkers; and extroverts, who are at an advantage over introverts. Similarly, anyone against whom the majority of those present are prejudiced is at a disadvantage compared to that majority. In an e-mail 'meeting', however, none of these issues come into play: everyone just sends an e-mail. This shows that in certain circumstances an e-mail meeting may be a much better way to collect the complete set of ideas and contributions of a group of people.

Activity 3

One of the threads that can be traced starting from SELF is:

SELF

Networks

Anne3

WANs

Ken2

WANs

Hilary2

This shows that Anne3, Ken2 and Hilary2 form a group that is in contact about WANs. Since a WAN is a particular kind of network, it also shows that SELF, Anne3, Ken2 and Hilary2 form a group that is in contact about Networks.

There are other threads that start from SELF, and threads that branch from these threads. They may be traced and interpreted similarly.

Review Question 1

$N*(N-1)$ because every code must in some exchange be converted to every other.

$2*(N-1)$ because all the codes (except ASCII itself) must be converted to and from ASCII.

Review Question 2

One area is clearly education, where widespread access to knowledge and expertise would be of obvious benefit to those in formal education and those to whom continuing education is an essential part of their job. Other areas include medicine, with the benefits that follow from ready access to medical advice, the law, with the benefits that follow from ready access to legal advice, and so on.

Review Question 3

The capabilities are, literally, provided not by the network but by the computers in the network. In particular, they are provided by the computers in the network that act as servers, that is, computers that are included in the network to provide services to other computers on the network.