Email

The at sign, a part of every SMTP email address[1]

Electronic mail, most commonly referred to as **email** or **e-mail** since ca. 1993,[2] is a method of exchanging digital messages from an author to one or more recipients. Modern email operates across the Internet or other computer networks. Some early email systems required that the author and the recipient both be online at the same time, in common with instant messaging. Today's email systems are based on a store-and-forward model. Email servers accept, forward, deliver, and store messages. Neither the users nor their computers are required to be online simultaneously; they need connect only briefly, typically to a mail server, for as long as it takes to send or receive messages.

Historically, the term *electronic mail* was used generically for any electronic document transmission. For example, several writers in the early 1970s used the term to describe fax document transmission.[3][4] As a result, it is difficult to find the first citation for the use of the term with the more specific meaning it has today.

An Internet email message[NB 1] consists of three components, the message *envelope*, the message *header*, and the message *body*. The message header contains control information, including, minimally, an originator's email address and one or more recipient addresses. Usually descriptive information is also added, such as a subject header field and a message submission date/time stamp.

Originally a text-only (ASCII) communications medium, Internet email was extended to carry, e.g. text in other character sets, multi-media content attachments, a process standardized in RFC 2045 through 2049. Collectively, these RFCs have come to be called Multipurpose Internet Mail Extensions (MIME). Subsequent RFC's have proposed standards for internationalized email addresses using UTF-8.

Electronic mail predates the inception of the Internet and was in fact a crucial tool in creating it,[5] but the history of modern, global Internet email services reaches back to the early ARPANET. Standards for encoding email messages were proposed as early as 1973 (RFC 561). Conversion from ARPANET to the Internet in the early 1980s produced the core of the current services. An email sent in the early 1970s looks quite similar to a basic text message sent on the Internet today.

Network-based email was initially exchanged on the ARPANET in extensions to the File Transfer Protocol (FTP), but is now carried by the Simple Mail Transfer Protocol (SMTP), first published as Internet standard 10 (RFC 821) in 1982. In the process of transporting email messages between systems, SMTP communicates delivery parameters using a message *envelope* separate from the message (header and body) itself.

Spelling

Electronic mail has several English spelling options that occasionally are the cause of vehement disagreement.[6][7]

- *e-mail* is the most common form in print, and is recommended by some prominent journalistic and technical style guides. According to Corpus of Contemporary American English data, this is the form that appears most frequently in edited, published American English and British English writing.[8]
- *email* is the most common form used online, and is required by IETF Requests for Comment and working groups[9] and increasingly by style guides.[10][11][12] This spelling also appears in most dictionaries.[13][14][15][16][17][18]
- *mail* was the form used in the original RFC. The service is referred to as *mail* and a single piece of electronic mail is called a *message*.[19][20][21]
- *eMail*, capitalizing only the letter *M*, was common among ARPANET users and the early developers of Unix, CMS, AppleLink, eWorld, AOL, GEnie, and Hotmail.
- *EMail* is a traditional form that has been used in RFCs for the "Author's Address",[20][21] and is expressly required "for historical reasons".[22]
- *E-mail* is sometimes used, capitalizing the initial letter *E* as in similar abbreviations like *E-piano*, *E-guitar*, *A-bomb*, *H-bomb*, and *C-section*.[23]

There is also some variety in the plural form of the term. In US English *email* is used as a mass noun (like the term *mail* for items sent through the postal system), but in British English it is more commonly used as a count noun with the plural *emails*.

Origin

The AUTODIN network provided a message service between 1,350 terminals, handling 30 million messages per month, with an average message length of approximately 3,000 characters. Autodin was supported by 18 large computerized switches, and was connected to the United States General Services Administration Advanced Record System, which provided similar services to roughly 2,500 terminals.[24]

Host-based mail systems

With the introduction of MIT's Compatible Time-Sharing System (CTSS) in 1961[25] multiple users were able to log into a central system[26] from remote dial-up terminals, and to store and share files on the central disk.[27] Informal methods of using this to pass messages developed and were expanded to create the first system worthy of the name "email":

- 1965 – MIT's CTSS MAIL.[28]

Other early systems soon had their own email applications:

- 1962 – 1440/1460 Administrative Terminal System[29]
- 1968 – ATS/360[30][31]
- 1972 – Unix mail program[32][33]
- 1972 – APL Mailbox by Larry Breed[34][35]
- 1974 – The PLATO IV Notes on-line message board system was generalized to offer

'personal notes' (email) in August, 1974.[24][36]
- 1978 – EMAIL at University of Medicine and Dentistry of New Jersey[37]
- 1981 – PROFS by IBM[38][39]
- 1982 – ALL-IN-1[40] by Digital Equipment Corporation

Though they are all similar in concept, these original email systems had widely different features and ran on systems that were incompatible with each other. They allowed communication only between users logged into the same host or "mainframe", although there might be hundreds or thousands of users within an organization.

LAN email systems

In the early 1980s, networked personal computers on LANs became increasingly important. Server-based systems similar to the earlier mainframe systems were developed. Again, these systems initially allowed communication only between users logged into the same server infrastructure. Examples include:

- cc:Mail
- Lantastic
- WordPerfect Office
- Microsoft Mail
- Banyan VINES
- Lotus Notes

Eventually these systems too could link different organizations as long as they ran the same email system and proprietary protocol.[41]

Email networks

Soon systems were developed to link compatible mail programmes between different organisations over dialup modems or leased lines, creating local and global networks.

- In 1971 the first ARPANET email was sent,[42] and through RFC 561, RFC 680, RFC 724, and finally 1977's RFC 733, became a standardized working system.

Other, separate networks were also being created including:

- Unix mail was networked by 1978's uucp,[43] which was also used for USENET newsgroup postings
- IBM mainframe email was linked by BITNET in 1981[44]
- IBM PCs running DOS in 1984 could link with FidoNet for email and shared bulletin board posting

Attempts at interoperability

Early interoperability among independent systems included:

- ARPANET, the forerunner of today's Internet, which defined the first protocols for dissimilar computers to exchange email
- uucp implementations for non-Unix systems, which were used as an open "glue" between

differing mail systems, primarily over dialup telephones
- CSNET, which used dial-up telephone access to link additional sites to the ARPANET and then Internet

There were later efforts at interoperability standardisation too:

- Novell briefly championed the open MHS protocol but abandoned it after purchasing the non-MHS WordPerfect Office (renamed Groupwise)
- The Coloured Book protocols on UK academic networks until 1992
- X.400 in the 1980s and early 1990s was promoted by major vendors and mandated for government use under GOSIP but abandoned by all but a few – in favor of Internet SMTP by the mid-1990s.

From SNDMSG to MSG

In the early 1970s, Ray Tomlinson updated an existing utility called SNDMSG so that it could copy messages (as files) over the network. Lawrence Roberts The project manager for the ARPANET development, took the idea of READMAIL, which dumped all "recent" messages onto the user's terminal, and wrote a programme for TENEX in TECO macros called *RD*, which permitted access to individual messages.[45] Barry Wessler then updated RD and called it *NRD*.[46]

Marty Yonke rewrote NRD to include reading, access to SNDMSG for sending, and a help system, and called the utility *WRD*, which was later known as *BANANARD*. John Vittal then updated this version to include three important commands: *Move* (combined save/delete command), *Answer* (determined to whom a reply should be sent) and *Forward* (sent an email to a person who was not already a recipient). The system was called *MSG*. With inclusion of these features, MSG is considered to be the first integrated modern email programme, from which many other applications have descended.[45]

Rise of ARPANET mail

The ARPANET computer network made a large contribution to the development of email. There is one report that indicates experimental inter-system email transfers began shortly after its creation in 1969.[28] Ray Tomlinson is generally credited as having sent the first email across a network, initiating the use of the "@" sign to separate the names of the user and the user's machine in 1971, when he sent a message from one Digital Equipment Corporation DEC-10 computer to another DEC-10. The two machines were placed next to each other.[47][48] Tomlinson's work was quickly adopted across the ARPANET, which significantly increased the popularity of email. For many years, email was the killer app of the ARPANET and then the Internet.

Most other networks had their own email protocols and address formats; as the influence of the ARPANET and later the Internet grew, central sites often hosted email gateways that passed mail between the internet and these other networks. Internet email addressing is still complicated by the need to handle mail destined for these older networks. Some well-known examples of these were UUCP (mostly Unix computers), BITNET (mostly IBM and VAX mainframes at universities), FidoNet (personal computers), DECnet (various networks) and CSNET, a forerunner of NSFNet.

Email

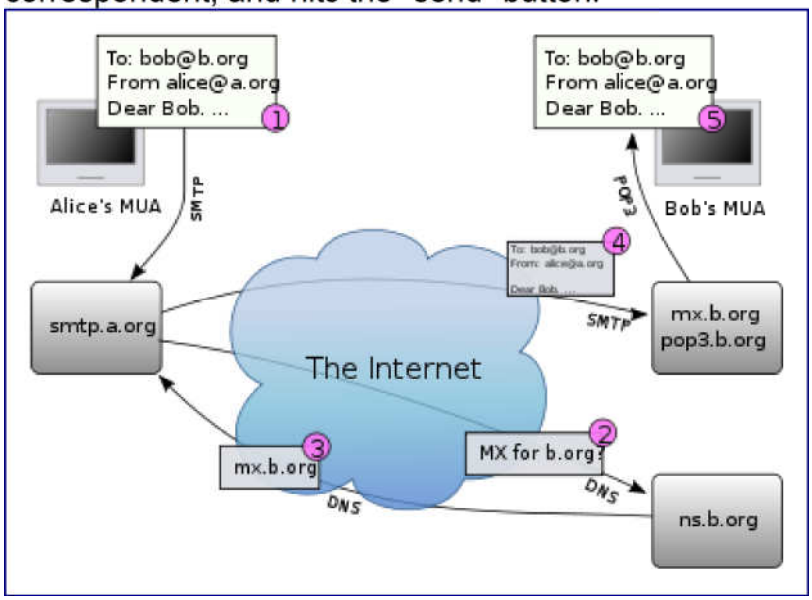
An example of an Internet email address that routed mail to a user at a UUCP host:

hubhost!middlehost!edgehost!user@uucpgateway.somedomain.example.com

This was necessary because in early years UUCP computers did not maintain (and could not consult central servers for) information about the location of all hosts they exchanged mail with, but rather only knew how to communicate with a few network neighbors; email messages (and other data such as Usenet News) were passed along in a chain among hosts who had explicitly agreed to share data with each other. (Eventually the UUCP Mapping Project would provide a form of network routing database for email.)

Operation overview

The diagram to the right shows a typical sequence of events[49] that takes place when Alice composes a message using her mail user agent (MUA). She enters the email address of her correspondent, and hits the "send" button.



1. Her MUA formats the message in email format and uses the Submission Protocol (a profile of the Simple Mail Transfer Protocol (SMTP), see RFC 6409) to send the message to the local mail submission agent (MSA), in this case smtp.a.org, run by Alice's internet service provider (ISP).
2. The MSA looks at the destination address provided in the SMTP protocol (not from the message header), in this case bob@b.org. An Internet email address is a string of the form localpart@exampledomain. The part before the @ sign is the *local part* of the address, often the username of the recipient, and the part after the @ sign is a domain name or a fully qualified domain name. The MSA resolves a domain name to determine the fully qualified domain name of the mail server in the Domain Name System (DNS).
3. The DNS server for the b.org domain, ns.b.org, responds with any MX records listing the mail exchange servers for that domain, in this case mx.b.org, a message transfer agent (MTA) server run by Bob's ISP.
4. smtp.a.org sends the message to mx.b.org using SMTP.

This server may need to forward the message to other MTAs before the message reaches the

final message delivery agent (MDA).

1. The MDA delivers it to the mailbox of the user bob.
2. Bob presses the "get mail" button in his MUA, which picks up the message using either the Post Office Protocol (POP3) or the Internet Message Access Protocol (IMAP).

That sequence of events applies to the majority of email users. However, there are many alternative possibilities and complications to the email system:

- Alice or Bob may use a client connected to a corporate email system, such as IBM Lotus Notes or Microsoft Exchange. These systems often have their own internal email format and their clients typically communicate with the email server using a vendor-specific, proprietary protocol. The server sends or receives email via the Internet through the product's Internet mail gateway which also does any necessary reformatting. If Alice and Bob work for the same company, the entire transaction may happen completely within a single corporate email system.
- Alice may not have a MUA on her computer but instead may connect to a webmail service.
- Alice's computer may run its own MTA, so avoiding the transfer at step 1.
- Bob may pick up his email in many ways, for example logging into mx.b.org and reading it directly, or by using a webmail service.
- Domains usually have several mail exchange servers so that they can continue to accept mail when the main mail exchange server is not available.
- Email messages are not secure if email encryption is not used correctly.

Many MTAs used to accept messages for any recipient on the Internet and do their best to deliver them. Such MTAs are called *open mail relays*. This was very important in the early days of the Internet when network connections were unreliable. If an MTA couldn't reach the destination, it could at least deliver it to a relay closer to the destination. The relay stood a better chance of delivering the message at a later time. However, this mechanism proved to be exploitable by people sending unsolicited bulk email and as a consequence very few modern MTAs are open mail relays, and many MTAs don't accept messages from open mail relays because such messages are very likely to be spam.

Message format

The Internet email message format is now defined by RFC 5322, with multi-media content attachments being defined in RFC 2045 through RFC 2049, collectively called *Multipurpose Internet Mail Extensions* or *MIME*. RFC 5322 replaced the earlier RFC 2822 in 2008, and in turn RFC 2822 in 2001 replaced RFC 822 – which had been the standard for Internet email for nearly 20 years. Published in 1982, RFC 822 was based on the earlier RFC 733 for the ARPANET.[50]

Internet email messages consist of two major sections:

- *Header* – Structured into fields such as From, To, CC, Subject, Date, and other information about the email.
- *Body* – The basic content, as unstructured text; sometimes containing a signature block at the end. This is exactly the same as the body of a regular letter.

The header is separated from the body by a blank line.

Message header

Each message has exactly one header, which is structured into fields. Each field has a name and a value. RFC 5322 specifies the precise syntax.

Informally, each line of text in the header that begins with a printable character begins a separate field. The field name starts in the first character of the line and ends before the separator character ":". The separator is then followed by the field value (the "body" of the field). The value is continued onto subsequent lines if those lines have a space or tab as their first character. Field names and values are restricted to 7-bit ASCII characters. Non-ASCII values may be represented using MIME encoded words.

Header fields

Email header fields can be multi-line, and each line should be at most 78 characters long and in no event more than 998 characters long.[51] Header fields defined by RFC 5322 can only contain US-ASCII characters; for encoding characters in other sets, a syntax specified in RFC 2047 can be used.[52] Recently the IETF EAI working group has defined some standards track extensions,[53][54] replacing previous experimental extensions, to allow UTF-8 encoded Unicode characters to be used within the header. In particular, this allows email addresses to use non-ASCII characters. Such characters must only be used by servers that support these extensions.

The message header must include at least the following fields:[55]

- *From*: The email address, and optionally the name of the author(s). In many email clients not changeable except through changing account settings.
- *Date*: The local time and date when the message was written. Like the *From:* field, many email clients fill this in automatically when sending. The recipient's client may then display the time in the format and time zone local to him/her.

The message header should include at least the following fields:[56]

- *Message-ID*: Also an automatically generated field; used to prevent multiple delivery and for reference in In-Reply-To: (see below).
- *In-Reply-To*: Message-ID of the message that this is a reply to. Used to link related messages together. This field only applies for reply messages.

RFC 3864 describes registration procedures for message header fields at the IANA; it provides for permanent and provisional message header field names, including also fields defined for MIME, netnews, and http, and referencing relevant RFCs. Common header fields for email include:[57]

- *To*: The email address(es), and optionally name(s) of the message's recipient(s). Indicates primary recipients (multiple allowed), for secondary recipients see Cc: and Bcc: below.
- *Subject*: A brief summary of the topic of the message. Certain abbreviations are commonly used in the subject, including "RE:" and "FW:".
- *Bcc*: Blind Carbon Copy; addresses added to the SMTP delivery list but not (usually)

listed in the message data, remaining invisible to other recipients.
- *Cc*: Carbon Copy; Many email clients will mark email in one's inbox differently depending on whether they are in the To: or Cc: list.
- Content-Type: Information about how the message is to be displayed, usually a MIME type.
- *Precedence*: commonly with values "bulk", "junk", or "list"; used to indicate that automated "vacation" or "out of office" responses should not be returned for this mail, e.g. to prevent vacation notices from being sent to all other subscribers of a mailing list. Sendmail uses this header to affect prioritization of queued email, with "Precedence: special-delivery" messages delivered sooner. With modern high-bandwidth networks delivery priority is less of an issue than it once was. Microsoft Exchange respects a fine-grained automatic response suppression mechanism, the X-Auto-Response-Suppress header.[58]
- *References*: Message-ID of the message that this is a reply to, and the message-id of the message the previous reply was a reply to, etc.
- *Reply-To*: Address that should be used to reply to the message.
- *Sender*: Address of the actual sender acting on behalf of the author listed in the From: field (secretary, list manager, etc.).
- *Archived-At*: A direct link to the archived form of an individual email message.

Note that the *To:* field is not necessarily related to the addresses to which the message is delivered. The actual delivery list is supplied separately to the transport protocol, SMTP, which may or may not originally have been extracted from the header content. The "To:" field is similar to the addressing at the top of a conventional letter which is delivered according to the address on the outer envelope. In the same way, the "From:" field does not have to be the real sender of the email message. Some mail servers apply email authentication systems to messages being relayed. Data pertaining to server's activity is also part of the header, as defined below.

SMTP defines the *trace information* of a message, which is also saved in the header using the following two fields:[59]

- *Received*: when an SMTP server accepts a message it inserts this trace record at the top of the header (last to first).
- *Return-Path*: when the delivery SMTP server makes the *final delivery* of a message, it inserts this field at the top of the header.

Other header fields that are added on top of the header by the receiving server may be called *trace fields*, in a broader sense.[60]

- *Authentication-Results*: when a server carries out authentication checks, it can save the results in this field for consumption by downstream agents.[61]
- *Received-SPF*: stores the results of SPF checks.[62]
- *Auto-Submitted*: is used to mark automatically generated messages.[63]
- *VBR-Info*: claims VBR whitelisting[64]

Message body

Content encoding

Email was originally designed for 7-bit ASCII.[65] Most email software is 8-bit clean but must assume it will communicate with 7-bit servers and mail readers. The MIME standard introduced character set specifiers and two content transfer encodings to enable transmission of non-ASCII data: quoted printable for mostly 7 bit content with a few characters outside that range and base64 for arbitrary binary data. The 8BITMIME and BINARY extensions were introduced to allow transmission of mail without the need for these encodings, but many mail transport agents still do not support them fully. In some countries, several encoding schemes coexist; as the result, by default, the message in a non-Latin alphabet language appears in non-readable form (the only exception is coincidence, when the sender and receiver use the same encoding scheme). Therefore, for international character sets, Unicode is growing in popularity.

Plain text and HTML

Most modern graphic email clients allow the use of either plain text or HTML for the message body at the option of the user. HTML email messages often include an automatically generated plain text copy as well, for compatibility reasons.

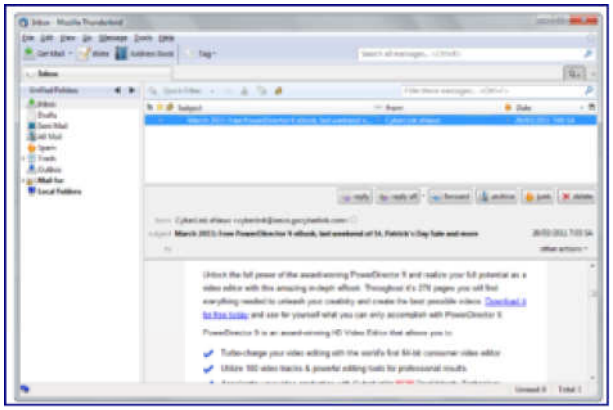
Advantages of HTML include the ability to include in-line links and images, set apart previous messages in block quotes, wrap naturally on any display, use emphasis such as underlines and italics, and change font styles. Disadvantages include the increased size of the email, privacy concerns about web bugs, abuse of HTML email as a vector for phishing attacks and the spread of malicious software.[66]

Some web based Mailing lists recommend that all posts be made in plain-text, with 72 or 80 characters per line[67][68] for all the above reasons, but also because they have a significant number of readers using text-based email clients such as Mutt.

Some Microsoft email clients allow rich formatting using RTF, but unless the recipient is guaranteed to have a compatible email client this should be avoided.[69]

In order to ensure that HTML sent in an email is rendered properly by the recipient's client software, an additional header must be specified when sending: "Content-type: text/html". Most email programs send this header automatically.

Servers and client applications



The interface of an email client, Thunderbird.

Messages are exchanged between hosts using the Simple Mail Transfer Protocol with software programs called mail transfer agents (MTAs); and delivered to a mail store by programs called mail delivery agents (MDAs, also sometimes called local delivery agents, LDAs). Users can retrieve their messages from servers using standard protocols such as POP or IMAP, or, as is more likely in a large corporate environment, with a proprietary protocol specific to Novell Groupwise, Lotus Notes or Microsoft Exchange Servers. Webmail interfaces allow users to access their mail with any standard web browser, from any computer, rather than relying on an email client. Programs used by users for retrieving, reading, and managing email are called mail user agents (MUAs).

Mail can be stored on the client, on the server side, or in both places. Standard formats for mailboxes include Maildir and mbox. Several prominent email clients use their own proprietary format and require conversion software to transfer email between them. Server-side storage is often in a proprietary format but since access is through a standard protocol such as IMAP, moving email from one server to another can be done with any MUA supporting the protocol.

Accepting a message obliges an MTA to deliver it,[70] and when a message cannot be delivered, that MTA must send a bounce message back to the sender, indicating the problem.

Filename extensions

Upon reception of email messages, email client applications save messages in operating system files in the file system. Some clients save individual messages as separate files, while others use various database formats, often proprietary, for collective storage. A historical standard of storage is the *mbox* format. The specific format used is often indicated by special filename extensions:

eml
: Used by many email clients including Microsoft Outlook Express, Lotus notes, Windows Mail, Mozilla Thunderbird, and Postbox. The files are plain text in MIME format, containing the email header as well as the message contents and attachments in one or more of several formats.

emlx
: Used by Apple Mail.

msg

Used by Microsoft Office Outlook and OfficeLogic Groupware.

mbx

Used by Opera Mail, KMail, and Apple Mail based on the mbox format.

Some applications (like Apple Mail) leave attachments encoded in messages for searching while also saving separate copies of the attachments. Others separate attachments from messages and save them in a specific directory.

Mobile devices, such as cell phones and tablet computers, commonly have the ability to receive e-mail. Since users may always have their mobile device with them, users may access e-mail significantly faster on these devices than through other methods, such as desktop computers or laptops.

URI scheme mailto

The URI scheme, as registered with the IANA, defines the mailto: scheme for SMTP email addresses. Though its use is not strictly defined, URLs of this form are intended to be used to open the new message window of the user's mail client when the URL is activated, with the address as defined by the URL in the *To:* field.[71]

Types

Web-based email (webmail)

Many email providers have a web-based email client (e.g. AOL Mail, Gmail, Outlook.com and Yahoo! Mail). This allows users to log into the email account by using any compatible web browser to send and receive their email. Mail is typically not downloaded to the client, so can't be read without a current Internet connection.

POP3 email services

POP3 is the acronym for Post Office Protocol 3. In a POP3 email account, email messages are downloaded to the client device (i.e. a computer) and then they are deleted from the mail server. It is difficult to save and view messages on multiple devices. Also, the messages sent from the computer are not copied to the Sent Items folder on the devices. The messages are deleted from the server to make room for more incoming messages. POP supports simple download-and-delete requirements for access to remote mailboxes (termed maildrop in the POP RFC's).[72] Although most POP clients have an option to leave messages on the server after downloading a copy of them, most e-mail clients using POP3 simply connect, retrieve all messages, store them on the client device as new messages, delete them from the server, and then disconnect.

IMAP email servers

IMAP refers to Internet Message Access Protocol. With an IMAP account, a user's account has access to mail folders on the mail server and can use any compatible device to read messages, as long as such a device can access the server. It shows the headers of messages, the sender

and the subject and the device needs to request to download specific messages. Usually mail is left in folders in the mail server.

MAPI email servers

Messaging Application Programming Interface (MAPI) is a messaging architecture and a Component Object Model based API for Microsoft Windows.

Use

Flaming

Flaming occurs when a person sends a message with angry or antagonistic content. The term is derived from the use of the word Incendiary to describe particularly heated email discussions. Flaming is assumed to be more common today because of the ease and impersonality of email communications: confrontations in person or via telephone require direct interaction, where social norms encourage civility, whereas typing a message to another person is an indirect interaction, so civility may be forgotten.

Email bankruptcy

Also known as "email fatigue", email bankruptcy is when a user ignores a large number of email messages after falling behind in reading and answering them. The reason for falling behind is often due to information overload and a general sense there is so much information that it is not possible to read it all. As a solution, people occasionally send a boilerplate message explaining that the email inbox is being cleared out. Harvard University law professor Lawrence Lessig is credited with coining this term, but he may only have popularized it.[73]

In business

Email was widely accepted by the business community as the first broad electronic communication medium and was the first 'e-revolution' in business communication. Email is very simple to understand and like postal mail, email solves two basic problems of communication: logistics and synchronization (see below).[74]

LAN based email is also an emerging form of usage for business. It not only allows the business user to download mail when *offline*, it also allows the small business user to have multiple users' email IDs with just *one email connection*.

Pros

- *The problem of logistics*: Much of the business world relies upon communications between people who are not physically in the same building, area or even country; setting up and attending an in-person meeting, telephone call, or conference call can be inconvenient, time-consuming, and costly. Email provides a way to exchange information between two or more people with no set-up costs and that is generally far less expensive than physical meetings or phone calls.

- *The problem of synchronisation*: With real time communication by meetings or phone calls, participants have to work on the same schedule, and each participant must spend the same amount of time in the meeting or call. Email allows asynchrony: each participant may control their schedule independently.

Cons

Most business workers today spend from one to two hours of their working day on email: reading, ordering, sorting, 're-contextualizing' fragmented information, and writing email.[75] The use of email is increasing due to increasing levels of globalisation – labour division and outsourcing amongst other things. Email can lead to some well-known problems:

- *Loss of context*: which means that the context is lost forever; there is no way to get the text back. Information in context (as in a newspaper) is much easier and faster to understand than unedited and sometimes unrelated fragments of information. Communicating in context can only be achieved when both parties have a full understanding of the context and issue in question.
- *Information overload*: Email is a push technology – the sender controls who receives the information. Convenient availability of mailing lists and use of "copy all" can lead to people receiving unwanted or irrelevant information of no use to them.
- *Inconsistency*: Email can duplicate information. This can be a problem when a large team is working on documents and information while not in constant contact with the other members of their team.
- *Liability*. Statements made in an email can be deemed legally binding and be used against a party in a court of law.[76]

Despite these disadvantages, email has become the most widely used medium of communication within the business world. In fact, a 2010 study on workplace communication, found that 83% of U.S. knowledge workers felt that email was critical to their success and productivity at work.[77]

Research on email marketing

Research suggests that email marketing can be viewed as useful by consumers if it contains information such as special sales offerings and new product information. Offering interesting hyperlinks or generic information on consumer trends is less useful.[78] This research by Martin et al. (2003) also shows that if consumers find email marketing useful, they are likely to visit a store, thereby overcoming limitations of Internet marketing such as not being able to touch or try on a product.

Problems

Speed of correspondence

Despite its name implying that its use is faster than either postal (physical) mail or telephone calls, correspondence over email often varies incredibly steeply — ranging from communication that is indeed semi-instant (often the fastest when a person is already sitting in front of a computer with their email program open, or when the person has email services automatically

set up to speedily check for new messages on their mobile phone) to communication that can quite literally take weeks or even months to garner a response. In the case of the latter, it often proves much more rapid to call the person via telephone or via some other means of audio. Therefore, as a rule, unless one's workplace or social circle already communicates heavily via email in a rapid manner, a person should assume that *email runs a perpetual risk of actually being slower as a communication mode than either mobile phone or text messaging communication*.

This general rule of thumb is often perplexing to those who use email heavily but whose colleagues and friends do not. Meanwhile, some people, due to exasperation with not getting responses to urgent messages, may eventually decline to use email with any regularity at all, and may be put in the sometimes-awkward position of having to notify their friends and colleagues who do use email regularly, that this is not a good way to reach them.

Attachment size limitation

Email messages may have one or more attachments, i.e. MIME parts intended to provide copies of files. Attachments serve the purpose of delivering binary or text files of unspecified size. In principle there is no technical intrinsic restriction in the InternetMessage Format, SMTP protocol or MIME limiting the size or number of attachments. In practice, however, email service providers implement various limitations on the permissible size of files or the size of an entire message.

Furthermore, due to technical reasons, often a small attachment can increase in size when sent, [79] which can be confusing to senders when trying to assess whether they can or cannot send a file by email, and this can result in their message being rejected.

As larger and larger file sizes are being created and traded, many users are either forced to upload and download their files using an FTP server, or more popularly, use online file sharing facilities or services, usually over web-friendly HTTP, in order to send and receive them.

Information overload

A December 2007 New York Times blog post described information overload as "a $650 Billion Drag on the Economy",[80] and the New York Times reported in April 2008 that "E-MAIL has become the bane of some people's professional lives" due to information overload, yet "none of the current wave of high-profile Internet start-ups focused on email really eliminates the problem of email overload because none helps us prepare replies".[81] GigaOm posted a similar article in September 2010, highlighting research that found 57% of knowledge workers were overwhelmed by the volume of email they received.[77] Technology investors reflect similar concerns.[82]

In October 2010, CNN published an article titled "Happy Information Overload Day" that compiled research on email overload from IT companies and productivity experts. According to Basex, the average knowledge worker receives 93 emails a day. Subsequent studies have reported higher numbers.[83] Marsha Egan, an email productivity expert, called email technology both a blessing and a curse in the article. She stated, "Everyone just learns that they have to have it dinging and flashing and open just in case the boss e-mails," she said. "The best gift any group can give each other is to never use e-mail urgently. If you need it within three hours, pick up the phone."[84]

Spamming and computer viruses

The usefulness of email is being threatened by four phenomena: email bombardment, spamming, phishing, and email worms.

Spamming is unsolicited commercial (or bulk) email. Because of the minuscule cost of sending email, spammers can send hundreds of millions of email messages each day over an inexpensive Internet connection. Hundreds of active spammers sending this volume of mail results in information overload for many computer users who receive voluminous unsolicited email each day.[85][86]

Email worms use email as a way of replicating themselves into vulnerable computers. Although the first email worm affected UNIX computers, the problem is most common today on the Microsoft Windows operating system.

The combination of spam and worm programs results in users receiving a constant drizzle of junk email, which reduces the usefulness of email as a practical tool.

A number of anti-spam techniques mitigate the impact of spam. In the United States, U.S. Congress has also passed a law, the Can Spam Act of 2003, attempting to regulate such email. Australia also has very strict spam laws restricting the sending of spam from an Australian ISP, [87] but its impact has been minimal since most spam comes from regimes that seem reluctant to regulate the sending of spam.

Email spoofing

Email spoofing occurs when the header information of an email is designed to make the message appear to come from a known or trusted source. Spam and phishing emails typically use such spoofing to mislead the recipient about the origin of the message.

Email bombing

Email bombing is the intentional sending of large volumes of messages to a target address. The overloading of the target email address can render it unusable and can even cause the mail server to crash.

Privacy concerns

Today it can be important to distinguish between Internet and internal email systems. Internet email may travel and be stored on networks and computers without the sender's or the recipient's control. During the transit time it is possible that third parties read or even modify the content. Internal mail systems, in which the information never leaves the organizational network, may be more secure, although information technology personnel and others whose function may involve monitoring or managing may be accessing the email of other employees.

Email privacy, without some security precautions, can be compromised because:

- email messages are generally not encrypted.
- email messages have to go through intermediate computers before reaching their destination, meaning it is relatively easy for others to intercept and read messages.
- many Internet Service Providers (ISP) store copies of email messages on their mail

servers before they are delivered. The backups of these can remain for up to several months on their server, despite deletion from the mailbox.
- the "Received:"-fields and other information in the email can often identify the sender, preventing anonymous communication.

There are cryptography applications that can serve as a remedy to one or more of the above. For example, Virtual Private Networks or the Tor anonymity network can be used to encrypt traffic from the user machine to a safer network while GPG, PGP, SMEmail,[88] or S/MIME can be used for end-to-end message encryption, and SMTP STARTTLS or SMTP over Transport Layer Security/Secure Sockets Layer can be used to encrypt communications for a single mail hop between the SMTP client and the SMTP server.

Additionally, many mail user agents do not protect logins and passwords, making them easy to intercept by an attacker. Encrypted authentication schemes such as SASL prevent this.

Finally, attached files share many of the same hazards as those found in peer-to-peer filesharing. Attached files may contain trojans or viruses.

Coincidence or agreement to require phone number

Recently in 2014 the major webmail providers like Google, Hotmail or Yahoo have agreed on the decision to require -as a condition for registration- to provide personal information such as mandatory phone numbers, or alternate email address that also request a mandatory phone number, to prevent service to users who do not want these companies control their mobile phones, or to prevent service to users who do not have financial means to own a phone.

Tracking of sent mail

The original SMTP mail service provides limited mechanisms for tracking a transmitted message, and none for verifying that it has been delivered or read. It requires that each mail server must either deliver it onward or return a failure notice (bounce message), but both software bugs and system failures can cause messages to be lost. To remedy this, the IETF introduced Delivery Status Notifications (delivery receipts) and Message Disposition Notifications (return receipts); however, these are not universally deployed in production. (A complete Message Tracking mechanism was also defined, but it never gained traction; see RFCs 3885 through 3888.)

Many ISPs now deliberately disable non-delivery reports (NDRs) and delivery receipts due to the activities of spammers:

- Delivery Reports can be used to verify whether an address exists and so is available to be spammed
- If the spammer uses a forged sender email address (email spoofing), then the innocent email address that was used can be flooded with NDRs from the many invalid email addresses the spammer may have attempted to mail. These NDRs then constitute spam from the ISP to the innocent user

There are a number of systems that allow the sender to see if messages have been opened.[89] [90][91][92] The receiver could also let the sender know that the emails have been opened through an "Okay" button. A check sign can appear in the sender's screen when the receiver's "Okay" button is pressed.

U.S. government

The U.S. federal government has been involved in email in several different ways.

Starting in 1977, the U.S. Postal Service (USPS) recognized that electronic mail and electronic transactions posed a significant threat to First Class mail volumes and revenue. Therefore, the USPS initiated an experimental email service known as E-COM. Electronic messages were transmitted to a post office, printed out, and delivered as hard copy. To take advantage of the service, an individual had to transmit at least 200 messages. The delivery time of the messages was the same as First Class mail and cost 26 cents. Both the Postal Regulatory Commission and the Federal Communications Commission opposed E-COM. The FCC concluded that E-COM constituted common carriage under its jurisdiction and the USPS would have to file a tariff.[93] Three years after initiating the service, USPS canceled E-COM and attempted to sell it off.[94][95][96][97][98][99]

The early ARPANET dealt with multiple email clients that had various, and at times incompatible, formats. For example, in the Multics, the "@" sign meant "kill line" and anything before the "@" sign was ignored, so Multics users had to use a command-line option to specify the destination system.[28] The Department of Defense DARPA desired to have uniformity and interoperability for email and therefore funded efforts to drive towards unified inter-operable standards. This led to David Crocker, John Vittal, Kenneth Pogran, and Austin Henderson publishing RFC 733, "Standard for the Format of ARPA Network Text Message" (November 21, 1977), which was apparently not effective. In 1979, a meeting was held at BBN to resolve incompatibility issues. Jon Postel recounted the meeting in RFC 808, "Summary of Computer Mail Services Meeting Held at BBN on 10 January 1979" (March 1, 1982), which includes an appendix listing the varying email systems at the time. This, in turn, lead to the release of David Crocker's RFC 822, "Standard for the Format of ARPA Internet Text Messages" (August 13, 1982).[100]

The National Science Foundation took over operations of the ARPANET and Internet from the Department of Defense, and initiated NSFNet, a new backbone for the network. A part of the NSFNet AUP forbade commercial traffic.[101] In 1988, Vint Cerf arranged for an interconnection of MCI Mail with NSFNET on an experimental basis. The following year Compuserve email interconnected with NSFNET. Within a few years the commercial traffic restriction was removed from NSFNETs AUP, and NSFNET was privatised.

In the late 1990s, the Federal Trade Commission grew concerned with fraud transpiring in email, and initiated a series of procedures on spam, fraud, and phishing.[102] In 2004, FTC jurisdiction over spam was codified into law in the form of the CAN SPAM Act.[103] Several other U.S. federal agencies have also exercised jurisdiction including the Department of Justice and the Secret Service.

NASA has provided email capabilities to astronauts aboard the Space Shuttle and International Space Station since 1991 when a Macintosh Portable was used aboard Space Shuttle mission STS-43 to send the first email via AppleLink.[104][105][106] Today astronauts aboard the International Space Station have email capabilities via the wireless networking throughout the station and are connected to the ground at 3 Mbit/s Earth to station and 10 Mbit/s station to Earth, comparable to home DSL connection speeds.[107]

See also

Email terminologies

- Email encryption
- HTML email
- Internet fax
- Privacy-enhanced Electronic Mail
- Dark Mail Alliance
- Push email
- X-Originating-IP

Email social issues

- Anti-spam techniques (email)
- CompuServe (first consumer service)
- Computer virus
- E-card
- Email art
- Email spam
- Email spoofing
- Email storm
- List of email subject abbreviations
- Information overload
- Internet humor
- Internet slang
- Netiquette
- Posting style
- Usenet quoting

Clients and servers

- Biff
- Email address
- Email authentication
- Email client, Comparison of email clients
- Email hosting service
- Internet mail standards
- Mail transfer agent
- Mail user agent
- Unicode and email
- Webmail, Comparison of webmail providers

Mailing list

- Anonymous remailer
- Disposable email address
- Email digest
- Email encryption
- Email tracking
- Electronic mailing list
- Mailer-Daemon
- Mailing list archive

History

- Telegraphy
- Lexigram

- MCI Mail

Protocols

- IMAP
- POP3
- SMTP
- UUCP
- X400

Notes

1. Unless explicitly qualified, any technical descriptions in this article will refer to current Internet e-mail rather than to earlier email systems.

References

1. "RFC 5321 – Simple Mail Transfer Protocol". *Network Working Group*. Retrieved 2010-02=October 2008.
2. *Google Ngram Viewer*. Books.google.com. Retrieved 2013-04-21.
3. Ron Brown, Fax invades the mail market, New Scientist, Vol. 56, No. 817 (Oct., 26, 1972), pages 218–221.
4. Herbert P. Luckett, What's News: Electronic-mail delivery gets started, Popular Science, Vol. 202, No. 3 (March 1973); page 85
5. See (Partridge 2008) for early history of email, from origins through 1991.
6. Long, Tony (23 October 2000). *A Matter of (Wired News) Style*. Wired magazine.
7. *Readers on (Wired News) Style*. Wired magazine. 24 October 2000.
8. ""Email" or "e-mail"". *English Language & Usage – Stack Exchange*. August 25, 2010. Retrieved September 26, 2010.
9. "RFC Editor Terms List". IETF. This is suggested by the RFC Document Style Guide
10. "Yahoo style guide". Styleguide.yahoo.com. Retrieved 2014-01-09.
11. AP Stylebook editors share big changes from the American Copy Editors Society
12. Gerri Berendzen; Daniel Hunt. "AP changes e-mail to email". *15th National Conference of the American Copy Editors Society (2011, Phoenix)*. ACES. Retrieved 23 March 2011.
13. AskOxford Language Query team. "What is the correct way to spell 'e' words such as 'email', 'ecommerce', 'egovernment'?". *FAQ*. Oxford University Press. Archived from the original on July 1, 2008. Retrieved 4 September 2009. "We recommend email, as this is now by far the most common form"
14. "Reference.com". Dictionary.reference.com. Retrieved 2014-01-09.
15. Random House Unabridged Dictionary, 2006
16. The American Heritage Dictionary of the English Language, Fourth Edition
17. Princeton University WordNet 3.0
18. The American Heritage Science Dictionary, 2002
19. "RFC 821 (rfc821) – Simple Mail Transfer Protocol". Faqs.org. 1971-06-11. Retrieved 2014-01-09.
20. "RFC 1939 (rfc1939) – Post Office Protocol – Version 3". Faqs.org. Retrieved 2014-01-

09.
21. "RFC 3501 (rfc3501) – Internet Message Access Protocol – version 4rev1". Faqs.org. Retrieved 2014-01-09.
22. """RFC Style Guide"", Table of decisions on consistent usage in RFC". Retrieved 2014-01-09.
23. "Excerpt from the FAQ list of the Usenet newsgroup alt.usage.english". Alt-usage-english.org. Retrieved 2014-01-09.
24. USPS Support Panel, Louis T Rader, Chair, Chapter IV: Systems, Electronic Message Systems for the U.S. Postal Service, National Academy of Sciences, Washington, D.C., 1976; pages 27–35.
25. "CTSS, Compatible Time-Sharing System" (September 4, 2006), University of South Alabama, USA-CTSS.
26. an IBM 7094
27. Tom Van Vleck, "The IBM 7094 and CTSS" (September 10, 2004), *Multicians.org* (Multics), web: Multicians-7094.
28. Tom Van Vleck. "The History of Electronic Mail".
29. IBM, *1440/1460 Administrative Terminal System (1440-CX-07X and 1460-CX-08X) Application Description*, Second Edition, IBM, p. 10, H20-0129-1.
30. IBM, *System/36O Administrative Terminal System DOS (ATS/DOS) Program Description Manual*, IBM, H20-0508.
31. IBM, *System/360 Administrative Terminal System-OS (ATS/OS) Application Description Manual*, IBM, H20-0297.
32. "Version 3 Unix mail(1) manual page from 10/25/1972". Minnie.tuhs.org. Retrieved 2014-01-09.
33. "Version 6 Unix mail(1) manual page from 2/21/1975". Minnie.tuhs.org. Retrieved 2014-01-09.
34. APL Quotations and Anecdotes, including Leslie Goldsmith's story of the Mailbox
35. History of the Internet, including Carter/Mondale use of email
36. David Wooley, PLATO: The Emergence of an Online Community, 1994.
37. Stromberg, Joseph (22 February 2012). "A Piece of Email History Comes to the American History Museum". Smithsonian Institution. Retrieved 11 June 2012.
38. *"...PROFS changed the way organizations communicated, collaborated and approached work when it was introduced by IBM's Data Processing Division in 1981..."*, IBM.com
39. *"1982 – The National Security Council (NSC) staff at the White House acquires a prototype electronic mail system, from IBM, called the Professional Office System (PROFs)...."*, fas.org
40. "Gordon Bell's timeline of Digital Equipment Corporation". Research.microsoft.com. 1998-01-30. Retrieved 2014-01-09.
41. with various vendors supplying gateway software to link these incompatible systems
42. Ray Tomlinson. "The First Network Email".
43. "Version 7 Unix manual: "UUCP Implementation Description" by D. A. Nowitz, and "A Dial-Up Network of UNIX Systems" by D. A. Nowitz and M. E. Lesk". Retrieved 2014-01-09.
44. "BITNET History", livinginternet.com
45. "Email History". Livinginternet.com. 1996-05-13. Retrieved 2014-01-09.
46. "The Technical Development of Internet Email" Craig Partridge, April–June 2008, p.5
47. Ray Tomlinson. "The First Email". Openmap.bbn.com. Retrieved 2014-01-09.

48.Wave New World,Time Magazine, October 19, 2009, p.48
49.*How E-mail Works* (internet video). howstuffworks.com. 2008.
50.Simpson, Ken (October 3, 2008). "An update to the email standards". MailChannels Blog Entry.
51.P. Resnick, Ed. (October 2008). "RFC 5322, Internet Message Format". IETF.
52.Moore, K (November 1996). "MIME (Multipurpose Internet Mail Extensions) Part Three: Message Header Extensions for Non-ASCII Text". IETF. Retrieved 2012-01-21.
53.A Yang, Ed. (February 2012). "RFC 6532, Internationalized Email Headers". IETF. ISSN 2070-1721.
54.J. Yao, Ed., W. Mao, Ed. (February 2012). "RFC 6531, SMTP Extension for Internationalized Email Addresses". IETF. ISSN 2070-1721.
55."RFC 5322, 3.6. Field Definitions". Tools.ietf.org. October 2008. Retrieved 2014-01-09.
56."RFC 5322, 3.6.4. Identification Fields". Tools.ietf.org. October 2008. Retrieved 2014-01-09.
57."RFC 5064". Tools.ietf.org. December 2007. Retrieved 2014-01-09.
58.Microsoft, Auto Response Suppress, 2010, microsoft reference, 2010 Sep 22
59.John Klensin (October 2008). "Trace Information". *Simple Mail Transfer Protocol*. IETF. sec. 4.4. RFC 5321.
60.John Levine (14 January 2012). "Trace headers". *email message*. IETF. Retrieved 16 January 2012. "there are many more trace headers than those two"
61.This extensible field is defined by RFC 7001, that also defines an IANA registry of Email Authentication Parameters.
62.RFC 4408.
63.Defined in RFC 3834, and updated by RFC 5436.
64.RFC 5518.
65.Craig Hunt (2002). *TCP/IP Network Administration*. O'Reilly Media. p. 70. ISBN 978-0-596-00297-8.
66."Email policies that prevent viruses".
67."When posting to a RootsWeb mailing list...". Helpdesk.rootsweb.com. Retrieved 2014-01-09.
68."...Plain text, 72 characters per line...". Openbsd.org. Retrieved 2014-01-09.
69."How to Prevent the Winmail.dat File from Being Sent to Internet Users". Support.microsoft.com. 2010-07-02. Retrieved 2014-01-09.
70.In practice, some accepted messages may nowadays not be delivered to the recipient's InBox, but instead to a Spam or Junk folder which, especially in a corporate environment, may be inaccessible to the recipient
71.RFC 2368 section 3 : by Paul Hoffman in 1998 discusses operation of the "mailto" URL.
72.Allen, David (2004). *Windows to Linux*. Prentice Hall. p. 192.
73.Barrett, Grant (December 23, 2007). "All We Are Saying.". New York Times. Retrieved 2007-12-24.
74.Aamoth, Doug (15 November 2011). "The Man Who Invented Email". *Time Magazine: Techland*. Retrieved 11 June 2012.
75."Email Right to Privacy – Why Small Businesses Care". Anita Campbell. 2007-06-19.
76.C. J. Hughes (February 17, 2011). "E-Mail May Be Binding, State Court Rules". *New York Times*. Retrieved 2011-02-20.
77.By Om Malik, GigaOm. "Is Email a Curse or a Boon?" September 22, 2010. Retrieved October 11, 2010.

78. Martin, Brett A. S., Joel Van Durme, Mika Raulas, and Marko Merisavo (2003), "E-mail Marketing: Exploratory Insights from Finland", *Journal of Advertising Research*, 43 (3), 293–300.
79. "Exchange 2007: Attachment Size Increase,...". TechNet Magazine, Microsoft.com US. 2010-03-25.
80. Lohr, Steve (2007-12-20). "Is Information Overload a $650 Billion Drag on the Economy?". New York Times. Retrieved May 1, 2010.
81. Stross, Randall (2008-04-20). "Struggling to Evade the E-Mail Tsunami". New York Times. Retrieved May 1, 2010.
82. "Did Darwin Skip Over Email?". Foundry Group. 2008-04-28.
83. Radicati, Sara. "Email Statistics Report, 2010".
84. Gross, Doug (July 26, 2011). "Happy Information Overload Day!". *CNN*.
85. Rich Kawanagh. The top ten email spam list of 2005. ITVibe news, 2006, January 02, ITvibe.com
86. How Microsoft is losing the war on spam Salon.com
87. Spam Bill 2003 (PDF)
88. M. Toorani, SMEmail – A New Protocol for the Secure E-mail in Mobile Environments, Proceedings of the Australian Telecommunications Networks and Applications Conference (ATNAC'08), pp. 39–44, Adelaide, Australia, December 2008. (arXiv:1002.3176)
89. Amy Harmon (2000-11-22). "Software That Tracks E-Mail Is Raising Privacy Concerns". The New York Times. Retrieved 2012-01-13.
90. "About.com". Email.about.com. 2013-12-19. Retrieved 2014-01-09.
91. "Webdevelopersnotes.com". Webdevelopersnotes.com. Retrieved 2014-01-09.
92. "Microsoft.com". Support.microsoft.com. Retrieved 2014-01-09.
93. In re Request for declaratory ruling and investigation by Graphnet Systems, Inc., concerning the proposed E-COM service, FCC Docket No. 79-6 (September 4, 1979)
94. History of the United States Postal Service, USPS
95. Hardy, Ian R; The Evolution of ARPANET Email; 1996-05-13; History Thesis Paper; University of California at Berkeley
96. James Bovard, The Law Dinosaur: The US Postal Service, CATO Policy Analysis (February 1985)
97. "Jay Akkad, The History of Email". Cs.ucsb.edu. Retrieved 2014-01-09.
98. "US Postal Service: Postal Activities and Laws Related to Electronic Commerce, GAO-00-188" (PDF). Retrieved 2014-01-09.
99. "Implications of Electronic Mail and Message Systems for the U.S. Postal Service , Office of Technology Assessment, Congress of the United States, August 1982" (PDF). Retrieved 2014-01-09.
100. "Email History, How Email was Invented, Living Internet". Livinginternet.com. 1996-05-13. Retrieved 2014-01-09.
101. Robert Cannon. "Internet History". Cybertelecom. Retrieved 2014-01-09.
102. Cybertelecom : SPAM Reference
103. Robert Cannon. "Can Spam Act". Cybertelecom. Retrieved 2014-01-09.
104. Cowing, Keith (2000-09-18). "2001: A Space Laptop | SpaceRef – Your Space Reference". Spaceref.com. Retrieved 2014-01-09.
105. "The Mac Observer – This Week in Apple History – August 22–31: "Welcome, IBM. Seriously," Too Late to License". Macobserver.com. 2004-10-31. Retrieved 2014-01-09.

106. Linzmayer, Owen W. (2004). *Apple confidential 2.0 : the definitive history of the world's most colorful company* ([Rev. 2. ed.]. ed.). San Francisco, Calif.: No Starch Press. ISBN 1-59327-010-0.
107. Bilton, Nick (January 22, 2010). "First Tweet from Space". *New York Times*.

Further reading

- Cemil Betanov, *Introduction to X.400*, Artech House, ISBN 0-89006-597-7.
- Marsha Egan, "Inbox Detox and The Habit of Email Excellence", Acanthus Publishing ISBN 978-0-9815589-8-1
- Lawrence Hughes, *Internet e-mail Protocols, Standards and Implementation*, Artech House Publishers, ISBN 0-89006-939-5.
- Kevin Johnson, *Internet Email Protocols: A Developer's Guide*, Addison-Wesley Professional, ISBN 0-201-43288-9.
- Pete Loshin, *Essential Email Standards: RFCs and Protocols Made Practical*, John Wiley & Sons, ISBN 0-471-34597-0.
- Partridge, Craig (April–June 2008). "The Technical Development of Internet Email" (PDF). *IEEE Annals of the History of Computing* (Berlin: IEEE Computer Society) **30** (2). ISSN 1934-1547
- Sara Radicati, *Electronic Mail: An Introduction to the X.400 Message Handling Standards*, Mcgraw-Hill, ISBN 0-07-051104-7.
- John Rhoton, *Programmer's Guide to Internet Mail: SMTP, POP, IMAP, and LDAP*, Elsevier, ISBN 1-55558-212-5.
- John Rhoton, *X.400 and SMTP: Battle of the E-mail Protocols*, Elsevier, ISBN 1-55558-165-X.
- David Wood, *Programming Internet Mail*, O'Reilly, ISBN 1-56592-479-7.
- Yoram M. Kalman & Sheizaf Rafaeli, Online Pauses and Silence: Chronemic Expectancy Violations in Written Computer-Mediated Communication, *Communication Research*, Vol. 38, pp. 54–69, 2011