

Coordination in Message-Based Environments: Restructuring Internet E-Mail to Accomplish Tasks

Juha Takkinen and Nahid Shahmehri

Laboratory for Intelligent Information Systems (IISLAB)

Department of Computer and Information Science, Linköpings universitet, Sweden

juhta@ida.liu.se and nsh@ida.liu.se

Abstract

In this paper we consider e-mail as a task management tool. Our general goal is to restructure the domain of e-mail. The purpose is to make e-mail even more suitable for message-based communication and coordination of work in virtual and real organizations, where many users are involved. Specifically, we aim to design a control mechanism to support the identification and delegation of tasks and dissemination of information to individuals and groups in an organization using e-mail. We present and briefly discuss the results of an explorative study of task management in an e-mail user's daily electronic life. Some basic relations for a task-oriented and user-centered restructuring of the e-mail domain are identified. A tentative framework named CUDOS (See the User Delegate in Our System) is described, and our ideas for a prototype are presented, with a previously developed conceptual model of information management in e-mail as a starting point.

1. Introduction

Electronic messages in the form of e-mail proliferate daily life in organizations today. The diversity of e-mail use is large [13][20]. People use the e-mail client as a time management tool, a task management tool, or an information management tool [13]. A helpdesk operator for a computer hall at a student campus, e.g., handles a large variety of e-mail messages, ranging from queries about accounts and available software to queries about policies and individuals of the organization. Furthermore, people have different roles in their organizations that affect their work situation, and subsequently their use of different information sources for filtering and managing messages and tasks. Some examples of roles are: teacher, supervisor, researcher, and system administrator.

The e-mail interface is still a too thin a layer on top of a delivery system. We aim to design a model and develop a prototype for use in e-mail to support a user in her management of tasks in e-mail in her different roles. By modeling different tasks we are restructuring the application domain of Internet e-mail (which uses SMTP and POP3/

IMAP protocols) and making it more usable for collaborative work in an organization.

This paper is organized as follows. A brief background and related work to task-oriented treatment and filtering of e-mail are given. An explorative study and its central results are presented and briefly analyzed. This is followed by the description of a framework for message-based task management, which is used for restructuring the domain of Internet e-mail. The framework is based on a previously constructed conceptual model for general management of information in e-mail, which is also briefly described. We conclude with our ideas of an implementation of the framework and future work.

2. Background

A task-oriented restructuring of the application domain of e-mail was initiated by Fleming and Kilgour [6]. A number of general tasks that users perform using e-mail were identified, such as problem solving, negotiation, discussion, and request for and dissemination of information. Different types of messages were also identified. By reinforcing and suppressing different characteristics of certain messages, the presentation on the screen was made more readable.

The basic functionality to manage tasks includes filtering (classification and prioritization) of messages. A survey of Internet e-mail clients [21] revealed that filtering based on keywords in message headers for handling incoming messages is common, as is the use of folders for storing messages, and two-paned or three-paned display of messages. An example of a commercially available, corporate-based e-mail system that incorporates the concept of tasks into e-mail in a very basic way is MEMO [23]. A "workflow item" arrives in the MEMO mailbox just like ordinary e-mail messages, forms and calendar invitations. MEMO has a calendar and scheduling functions, as well as electronic forms (cf. [14]). However, to manage the tasks in MEMO conventions must be followed by all workgroup members. An innovative, more dynamic and personalized message filter is CLUES [15]. Although it does not use the concept of tasks, it however infers message timeliness by

considering information available in a user's electronic environment, such as calendar appointments, outgoing messages and phone calls, and by correlating these data via a personal rolodex. An example of another simple, yet powerful and generic, tool for the management of distributed work is the TaskManager [11]. It was designed to encourage the organization of tasks and cooperative work by the end-users themselves, with minimal initial formalization—the only mandatory attribute of a task is its title.

The common goal of the systems above is to achieve a more “intelligent” or structured filtering or organization of the information, on a level conceptually higher than simple keywords (and closer to a user's own vocabulary and concepts). Some of the challenges we see are:

- to keep track of a user's interests (short-term, long-term, and recurrent)
- to formalize tasks for the effective internal processing by the system [16]
- to effectively combine synchronous communication with e-mail [18].

3. An explorative study

We adopted a user-centered approach based on a modified model of methods by Bryce [1]. Since information technology is only one part of an information system, we wished to get an understanding of the general workspace a user has for performing message-based tasks. Both interviews and questionnaires were employed. During interviews, the subjects were asked to refer to actual (exchanges of) messages in their e-mail. Questionnaires were used primarily to collect data about the scale and patterns of usage of e-mail systems. Interviews were used to probe knowledge and use of features of existing e-mail systems, as well as other (electronically or not) available sources, to manage tasks.

The questionnaires were distributed by e-mail to mailing lists within two computer-related departments at the university, to two student choirs, and to a group of alumni computer science students. A total of 158 questionnaires were returned, which we grouped into four categories: doctoral students (55 in all), other academic people working at the university (54), industry people working outside the university (32), and undergraduate students (17). The groups are henceforth coded DS, AP, IP, and US, respectively. The questionnaires were used primarily to collect data about the scale and patterns of usage of functions such as forwarding, filtering, templates, aliases, and address book. We concentrated on (current and future) scenarios where tasks were delegated and information was disseminated. Furthermore, four subjects from the authors' university were interviewed and some of their roles studied:

a helpdesk operator, a doctoral student, a professor and director of a research group, and an associate professor.

3.1 The results

Some of the results of the study were [22]:

- advanced formatting of messages by using extra bold type, HTML, etc. is rarely done because it takes time and the messages are mostly short, and because the receiving side cannot be presupposed to see the same layout
- templates (other than signature files) are not widely employed because they are a hindrance and most messages are short
- forwarding messages is very popular: a new message is created via a forward button, the recipient(s) and a subject line are added to the header, and some explanatory text is put in the body of the message; furthermore, the forwarded messages tend to be of lesser importance to the subject who is doing the forwarding
- confirming the delivery of messages is generally cumbersome with Internet e-mail; typically the telephone is used to confirm important messages; some subjects even used ICQ¹ [9] or the Unix command **finger** to verify message arrivals
- accessing one's e-mail is sometimes done from different computers using different e-mail clients, and being in different roles depending on the place where the e-mail is accessed from.

The DS and the IP tended to read e-mail as it arrives, while other AP read mail in intervals. Generally, e-mail is regarded as extremely useful, especially by the AP. Filtering is used mostly by the DS (41 %) and the IP (38 %) in the study. The AP had the largest spread of the number of mailing lists, 1–50, while the other groups had a more modest spread of 1–22 (DS) and 1–15 (US and IP). The US were most unsure (24 %) about the number of mailing lists they were subscribed to, as compared to the other groups (7–15 %).

3.2 Conclusions of the study

Traditional rule-based mail filtering systems are difficult to configure [20] and the rules do no change to reflect daily or weekly activity, i.e., short-term interests [15]. Furthermore, the mobility of users indicates that different rules are needed for different electronic environments and roles.

It was a bit surprising that advanced formatting was not so popular to use. In an earlier study [20] the most requested

1. A popular Internet tool developed in Israel that informs a user who's on-line, i.e., registered at an ICQ server, at any time and enables her to contact them at will.

function in e-mail was better functions for layout in messages. One of the explanations for this difference is probably the good handling of attachments that has evolved since the introduction of MIME [7]. Today, if text with better layout is wanted it is simply created with a word processor and sent as an attachments. This was evident from the answers in the questionnaire in our explorative study.

The problem with confirming the deliverance of a message is being solved by IETF with the introduction of message disposition notifications (MDNs) into the message header [5].

A task can be defined as an exchange of more or less naturally chained messages (a conversation). Small tasks can be contained within a thread of messages (usually with the same subject). Certain types of messages dominate certain tasks. For example, the action memo, or a Policy message [4], is typically used for delegating tasks within a project [6]. Some other message types are shown in table 1

Table 1: Message types

Policy (POL)	A message outlining some policy or answering a procedural question, including capabilities or use of a system (defined by the mailing list, for example). Example: "To login to System-X, type..."
Comment (COM)	A message giving a comment on (or opinion) about policy—and it may be in reply to a Policy or a RFC. Example: "To answer Jane's question, I agree, we should..."
Request for Comments (RFC)	A message asking for comments on a policy or system. Example: "Who's using review boards..."
Problem (PROB)	A message (a question) for help with (or for clarification of) a policy. Example: "Since when have we treated CPR teams that way?"
Announcement (ANN)	A message about a job opening, a flat available for renting, etc.
Personal/Member (PERS)	A message of the type "Merry Christmas, John!" or "Please welcome Mary to the mailing list"
Unclassified (UNCL)	Messages that cannot be classified as one (or more) of the above types

(modified from [4]). Hence, threads and message types can be employed to keep track of tasks. Confirming the finishing of a task must consider the possibility of a user employing synchronous communication (e.g., telephone or ICQ), i.e., there has to be some way of explicitly marking a task (a thread) in e-mail as completed. This function mimics the kill files used in netnews.

4. Restructuring e-mail: towards a framework

4.1 Our starting point: a conceptual model

We have previously developed CAFE (a Categorization

Assistant For E-mail), a conceptual model for information management in e-mail [21]. A user can explicitly tell the system her state of mind via three modes (fig. 1). The Cool

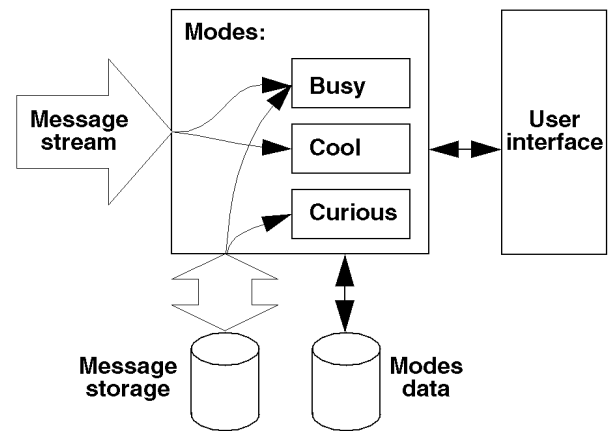


Fig. 1: CAFE and its three modes (mental states of a user).

mode (default) contains the traditional filtering of messages available in e-mail today, including a user's own folders. It operates on the incoming message stream. The Curious mode is invoked when a user has much time on her hand and she wishes to (re-)organize messages from, e.g., a mailing list available in the message storage of the user. The Busy mode is invoked at times of high stress and makes use of system-defined folders to organize new and unseen (incoming and stored) messages in priority order. An implementation of CAFE [21] required using a different information retrieval and filtering technique for each mode.

We are now extending CAFE, concentrating on the Busy mode. However, our overall goal is to construct a framework that can be used to refine and extend each mode in CAFE. In the Busy mode we have a relatively small and limited number of messages and the interesting problem of modeling a user's short-term interests. We are specifically interested in messages that a user puts on her to-do list, since these are often connected to tasks.

Capturing a user's short-term interests requires access to time-varying information about the user. Timely information can be found in some or all of the following sources:

- messages in a user's to-do folder
- the outgoing messages
- the address book
- the calendar tool
- the bookmarks of the web browser
- the database over employees in the organization.

A user's short-term interests can to some degree be

dynamically modeled by using the data available in the sources listed above, as shown in CLUES [15]. This approach has the appealing property that it does not require any extra effort from a user. CLUES lacks however adaptivity, i.e., it does not improve with experience. Furthermore, it is not exact—it does not distinguish in relevance between appointments that are to take place in ten minutes and one week, respectively, or between messages from someone a user has been e-mailing frequently over the last three days and one that happened to match an entry in the calendar three weeks away.

We hypothesize that the information from the different sources above can be used as a basis to identify the different types of messages that characterize tasks and projects. Furthermore, by making the learning process central to the classification process, we can make the system adaptive. The exactness of the system can be improved by, e.g., weighting the items in the calendar, as noted by [15].

4.2 A brief look at the domain and its terminology

Systems should use the domain-oriented representations used to communicate unambiguously between humans when possible [19]. We find that underlying a user's tasks and the presentation of messages are the system services and functions. The system functions are based on the technical structure of e-mail [3][7]. The relations between the basic technical structure of e-mail, system services and functions, user task, message types, and the presentation of messages are described in fig. 2 (the arrows show the building or realizing function that the items in fig. 3 have, e.g. "system functions realize system services"):

- the system services describe what a user can do with the system, and the user interface describes how she can do it
- the system functions realize the system services as perceived by a user ([12], p. 14) (fig. 3)
- the tasks include structured forms of communication, such as information request, information dissemination, negotiation, problem solving, arranging meetings, and group discussion, as well as unstructured forms of communication, such as chatting [6]
- an example of a set of message types is shown in table 1, derived from [4].

Furthermore, the system services and functions are described on both an abstract and a concrete level. As an example [19]:

- the abstract system service "communicate with others" is realized by the abstract system functions "receive a message," "send a message," and "automate communication"
- the concrete system service "compose a message" is

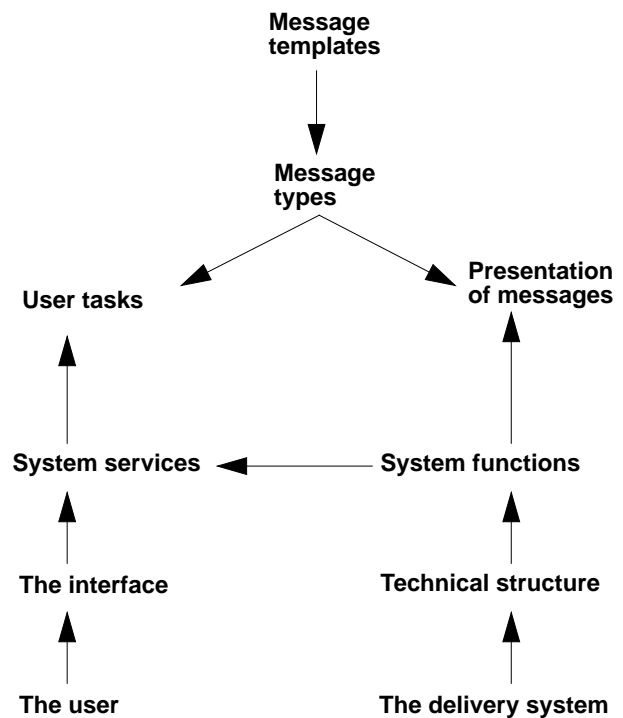


Fig. 2: Basic relations for restructuring the domain of e-mail.

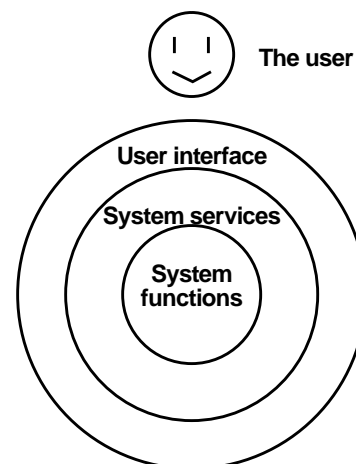


Fig. 3: The system services and the interface.

realized by the concrete system functions "fill in message header," "write text," "answer a received message," "forward message," and "append attachment".

4.3 A framework

Filtering messages based on tasks make it possible to construct an intuitively understandable, task-centered *control mechanism* to support the delegation of tasks to individuals in an organization. Our meaning of "a control mechanism" is threefold:

- a framework named CUDOS (See the User Delegate in Our System) for handling tasks and message types
- algorithms for filtering e-mail
- a prototype implementing CUDOS in the refined and extended CAFE.

The framework is shown in fig. 4. The dotted line

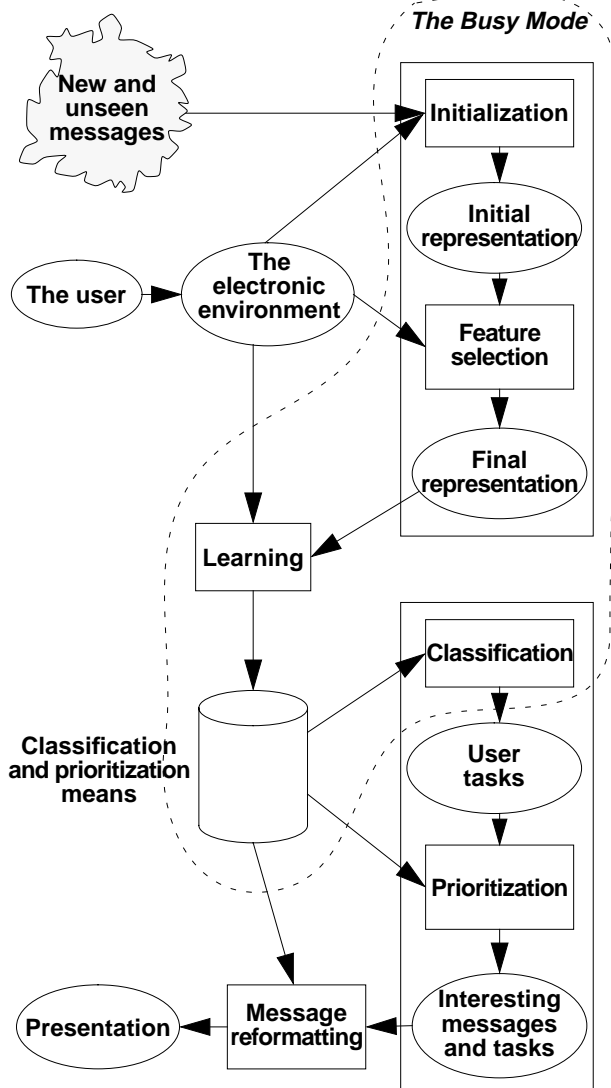


Fig. 4: CUDOS—a framework for handling tasks in e-mail.

represents the Busy mode of CAFE [21], which is used as the starting point for our framework. An initial representation is created from the messages, combining it with information available in a user's electronic environment. Data from the learning component are gathered and used for classifying tasks and prioritizing them. Before the messages are presented to the user they are reformatted according their respective types.

We note that a user's roles are implicit in the final representation of the messages as a combination of the current electronic environment (computer and work place) and selected task-dependent features of message.

5. Towards a prototype

Extending CAFE by applying CUDOS on all of the modes of CAFE will refine the modes and make them more personalized and task-oriented.

A prototype parses messages for "interesting" words, i.e., proper nouns, and words in header and body that are not stopwords. It suggests to a user how a message has been classified and prioritized in relation to a task, and which recipients could be interested in the message. A user should be able to instruct the system to keep track of a task. When formatting a message for presentation to a user, features (header fields) that are more important (less important) for the current type of the message are reinforced (suppressed).

We are examining machine learning algorithms [2][17] and combining them with domain knowledge. Since users are unwilling to make structure, content, or procedures explicit [19], we must make implicit aspects of a user's tasks explicit. This can be accomplished, e.g., by using incremental and system-assisted formalization mechanisms [11]. One formalization mechanism to access the meanings and contents of messages is the use of speech act theory (SAT) [10]. However, we are aware that users are hesitant about formalization because of fear of prematurely committing to a specific perspective on their tasks [19] (cf. [24]). The system should provide services based on inferred structure in informally represented information. Our final goal includes:

- a method for restructuring an application domain
- a complete framework (with respect to CAFE) for managing message-based tasks
- a multi-agent-based prototype implementing our ideas [8].

Acknowledgments

This work is supported by the Swedish Foundation for Strategic Research. We thank the anonymous referees of our paper for their constructive comments.

References

- [1] Bryce, A. (1996), *Information Tasks. Towards a User-Centered Approach to Information Systems*. San Diego: Academic Press, p. 24.
- [2] Cohen, W. W. (1996), "Learning Rules that Classify E-Mail," in *AAAI Spring Symposium on Machine Learning in Information Access, Stanford, March 25-27*.
- [3] Crocker, D. (1982), "Standard for the format of ARPA Internet text messages," *RFC822, August 13*. Updated by RFC1123, RFC1138, RFC1148, RFC1327.

- [4] Crowston, K., Malone, T. W., & Lin, F. (1988), "Cognitive Science and Organizational Design: A Case Study of Computer Conferencing," in *Human-Computer Interaction, 1987-1988, Vol. 3*, 59-85.
- [5] Fajman, R. (1998), "An Extensible Message Format for Message Disposition Notifications," *Internet draft, February 6*. <ftp://ftp.nordu.net/internet-drafts/draft-ietf-receipt-mdn-08.txt>
- [6] Fleming, S. T. & Kilgour, A. C. (1994), "Electronic Mail: Case Study in Task-Oriented Restructuring of Application Domain," in *IEE Proceedings: Computers and Digital Techniques*, 141(2), 65-71.
- [7] Freed, N. & Borenstein, N. (1996), "Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies," *RFC2045, Internet Draft Standard, November*. Obsoletes RFC1521, RFC1522, and RFC1590. Updated by RFC2184 and RFC2231.
- [8] Genesereth, M. R. (1997), "An Agent-Based Framework for Interoperability," in J. M. Bradshaw (Ed.) *Software Agents*, 317-345. AAAI Press. ISBN 0-262-52234-9.
- [9] - (1998), *ICQ—World's Largest Internet Online Communication Network*. <http://www.mirabilis.com/>
- [10] Kimbrough, S. O. & Moore, S. A. (1997), "On Automated Message Processing in Electronic Commerce and Work Support Systems: Speech Act Theory and Expressive Felicity," in *ACM Transactions on Information Systems*, 15(4), 321-367.
- [11] Kreifelts, T., Hinrichs, E., & Woetzel, G. (1993), "Sharing To-Do Lists with a Distributed Task Manager," in *Proc. of ECSCW'93, September 15-17, Milano, Italy*. Kluwer Academic Publishers.
- [12] Löwgren, J. (1993), *Human-computer interaction: what every system developer should know*. Lund: Studentlitteratur, ISBN 91-44-39651-1.
- [13] Mackay, W. (1988), "Diversity in the Use of Electronic Mail: A Preliminary Inquiry," in *ACM Transactions on Office Information Systems*, 6(4), 380-397.
- [14] Malone, T. W., Grant, K. R., Lai, K-Y, Rao, R., & Rosenblitt, D. (1987), "Semistructured Messages Are Surprisingly Useful for Computer-Supported Coordination," in *ACM Transactions on Office Information Systems*, 5(2), 115-131.
- [15] Marx, M. & Schmandt, C. (1996), "CLUES: Dynamic Personalized Message Filtering," in *Proc. of CSCW'96*, 113-121.
- [16] Mazer, M. S. (1988), "Problems in Modelling Tasks and Task Views," in *COOIS'88*, 38-45. ACM Press.
- [17] Mitchell, T. M. (1997), *Machine Learning*. McGraw-Hill. ISBN 0-07-042807-7.
- [18] Sakamoto, Y. & Kuwana, E. (1993), "Toward integrated support of synchronous and asynchronous communication in cooperative work: An empirical study of real group communication," in S. Kaplan (Ed.) *COOCS'93*, 90-97. ACM Press.
- [19] Shipman, F. M. & Marshall, C. C. (1994), *Formality Considered Harmful: Experiences, Emerging Themes, and Directions*. Xerox PARC technical report ISTL-CSA-94-08-02.
- [20] Takkinen, J. (1994), *CASUAR – en prototyp av ett användargränssnitt med filtrering och automatik för hantering av elektronisk post*. In Swedish. M.Sc. Thesis, Linköpings universitet, Sweden.
- [21] Takkinen, J. & Shahmehri, N. (1998) "CAFE: A Conceptual Model for Managing Information in Electronic Mail," in *Proc. of 31st Hawaii International Conference on System Sciences (HICSS-31)*, January 6-9, Honolulu, Hawaii, USA.
- [22] Takkinen, J. (1998), *Fallstudie av uppgiftslösning i e-post: resultat*. In Swedish. Internal memo. Lab. for Intelligent Information Systems, Dept. of Computer and Information Science, Linköpings universitet.
- [23] - (1998), *Verimation headlines*. <http://www.verimation.se/>
- [24] Winograd, T. & Flores, F. (1986), *Understanding computers and cognition: A new foundation for design*. Ablex Publishing Corporation, Norwood, New Jersey.