Integrating Multi-Modal Messages across Heterogeneous Networks

Liscano, R.; Impey, Roger; Yu, Q.; Abu-Hakima, S.

Integrating Multi-Modal Messages across Heterogeneous Networks.

Ramiro Liscano, Roger Impey, Qinxin Yu* and Suhayya Abu-Hakima

Institute for Information Technology, National Research Council Canada,
Montreal Road, Building M-50, Ottawa, Ontario, K1A 0R6.

Ramiro Liscano:	liscanco@iit.nrc.ca, (613) 993-6565, Fax: (613) 952-7151.
Roger Impey :	impey@iit.nrc.ca, (613) 991-6974, Fax: (613) 952-7151.
Qinxin Yu:	qyu@dgp.utoronto.ca, (416) 978 6025, Fax: (416) 978 1931
Suhayya Abu-Hakima :	Abu-Hakima@iit.nrc.ca, (613) 991-1231, Fax: (613) 952-7151.

Abstract

We introduce a seamless messaging system for the management of personal messages. The aim of it is to intercept, filter, interpret, and deliver multi-modal messages (voice, fax, and/or e-mail messages). Messages are delivered to the recipient regardless of their target messaging device. Seamless messaging involves finding the person (if urgent) and delivering the information to them on their cellular phone, pager, laptop, nearest fax, telephone, or desktop computer. The system includes a set of personal agents that classify and act on incoming messages based on their content. The user specifies the classes and actions to the agent as a set of high-level rules. This allows the user to specify rules that are independent of the messaging system and target devices. A personal agent "Secretary" is responsible for mediating between the different messaging environments, the target devices, and other interacting applications (e.g., calendars, e-mail programs, etc.). The design of this Seamless Messaging System is based on the integration of three technologies, ubiquitous computing, information filtering, and telematics. The system has been implemented on a Lotus Notes platform. What makes the system unique is its approach to treating a message in a universal manner, its ability to mediate between different messaging devices, and its ability to try to determine the availability of the user.

* Present Address: Department of Computer Science, University of Toronto, 10 King's College Road, Toronto, Ontario, M5S 3G4.

1. Introduction

A new era of communications is commencing with the development of Personal Communication Systems (PCS) that will allow communication with persons wherever they are, support personal mobility from one terminal to another, support mobile terminals, support user customized services, and a universal personal identification number. This paper addresses the problems associated with the management of personal messages across heterogeneous networks and considers this as an important functionality of a PCS system. This field of study we call "Seamless Messaging" (SM) and primarily involves the integration of the following key technologies, information filtering, and telematics. The SM paradigm allows the recipient of the message be located if necessary and the message tailored to the recipient's active target device. SM allows users to work in distributed personal workspaces and have messages created and delivered how, when, where, and if they wish them to be. In this environment wireless networks will be essential in supporting mobile and remote access.

As communication barriers across networks come down, the amount of information readily available increases dramatically and it becomes necessary to filter that information, both to make the end-user more efficient and reduce the cost of processing the information. For example, currently wireless communication's transmission data rates are slow and air time is expensive and therefore messages with large information content must be filtered. Information filtering and filtering of mail messages have been a research topic for a number of years and are not a main topic of discussion in this article, but are usually integrated into a system for the management of messages.

The area of telematics[2][3] is an investigation of remote monitoring and is crucial to the addition of enhanced intelligence and background computing. Current messaging systems rely on the user directly specifying their schedule and location so that messages may be routed appropriately. The use of telematics on current computing environments will reduce the amount of information a user has to specify to the system since some of this information can be deduced from other sources. For example, monitoring a person's electronic schedule and integrating this with the state of their personal devices can be used to determine how an urgent message can be delivered to them.

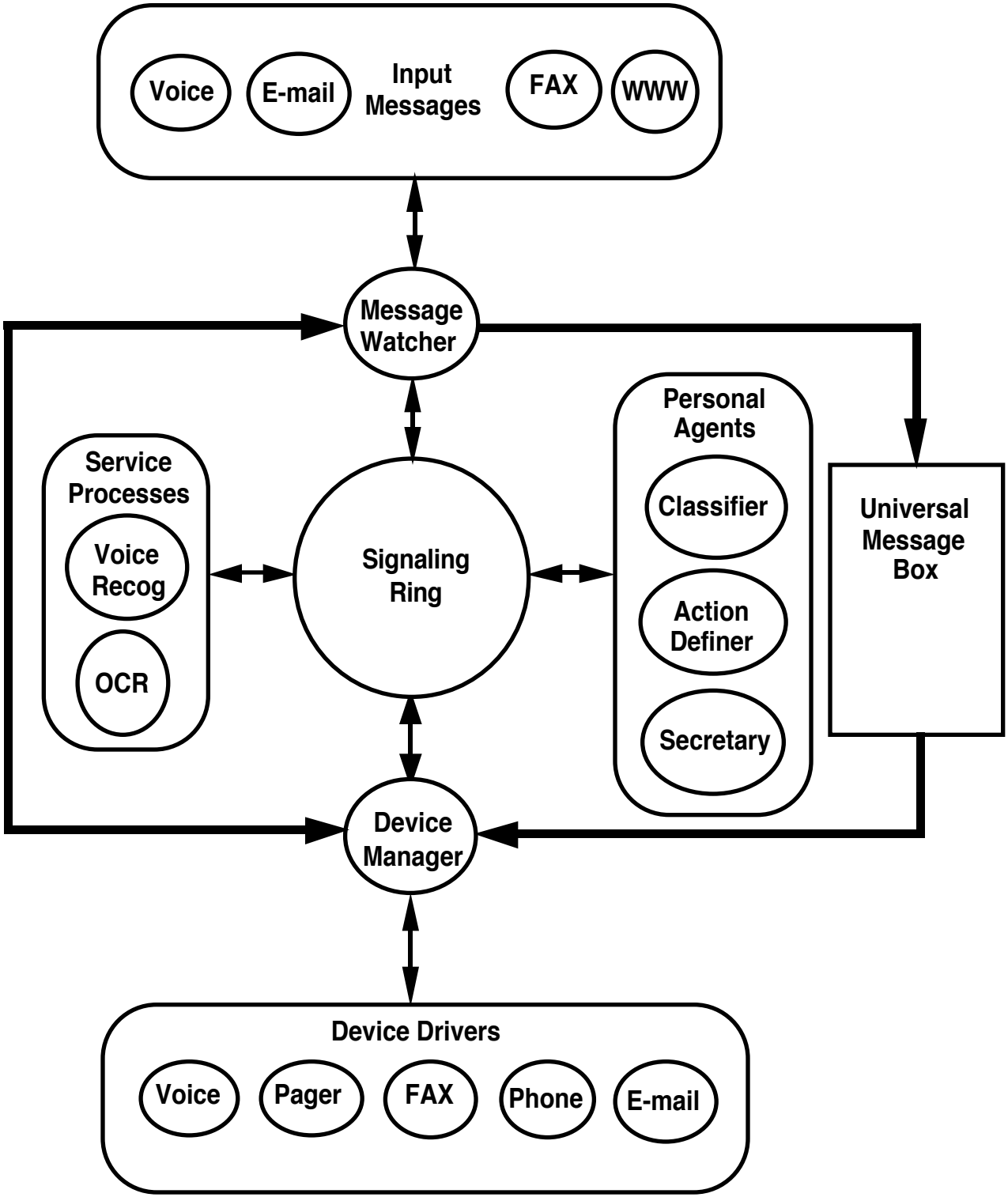

Figure 1. System Architecture

2. Modeling Seamless

In developing a model for Seamless Messaging the system must exhibit certain features; the ability to manage both asynchronous and isochronous message modalities, be easily customized by the end user, and be modular enough that features to the system can easily be added or removed. For asynchronous communications the system maintains a universal message box that can handle multi-modal messages. Isochronous messaging requires timely delivery of the message and must consider the result of delays The system modules or processes can be divided into 4 groups of processes: the "Message Watcher", the "Personal Agents", the "Device Manager", and the "Service Processes". The "Message Watcher" processes are designed as monitoring processes that wait for incoming messages and format these messages into a unified representation for the system to process. They are the first processes that are triggered in the system. The "Personal Agents" are software processes designed to act on behalf of the user by performing a particular task. All personal agents share one common design criteria; they are designed to perform a particular well defined task based on a set of constraints specified by the user and must be customizable by the user at run time. The "Device Manager" attempts to deliver the message by invoking the appropriate device driver and passing it the required information. on the source of the data. Figure 1 shows the structure of the SM system and the flow of information between the processes of the system. Notice that there are 2 paths for a message to take, either into the universal message box if it is asynchronous (connectionless) or directly connected to the output device drivers for isochronous communications. The internal signaling ring is used to handle control signals among the processes of the SM system.

2.1 Workflow

The "Signaling Ring" is used to symbolize the fact that the processes communicate with each other by placing inter-process message blocks into a common area that the other processes have access to. Message blocks contain an identification tag which triggers the appropriate recipient process to take the message out of the common area and interpret it. The system is easily extendible by defining a new process and the type of messages the process should respond to. Although conceptually any process can communicate with another process on the message ring, in reality the workflow is predetermined.

The system is triggered by some message arriving and this message can be any one of several types, (e.g., Email, FAX, Voice, etc.). The initiation of the workflow is performed by the "Message Watcher" processes which place a control block on the "Signaling Ring" together with the identification tag that will indicate the next operation to be performed on

the message. Normally, the identification tag will trigger the "Classifier" agent to read the control block and retrieve the required information about the message. The "Classifier" agent formats a new control block which it places on the Signaling Ring indicating the message has been successfully classified. The next step is taken by the "Action Definer" which defines the action to be performed based on the class of the message. Again, a new control block is created by the "Action Definer" and placed on the ring. This time the "Secretary" agent is triggered whose role is to interpret any of the actions associated with the message. There will be some situations where the "Secretary" may not have sufficient information to process the message, for example when the message is of an urgent type and the user must be located. In this case additional resources are required to help find the user. Once the "Secretary" determines what device is to handle the message, a control block is created and placed on the "Signaling Ring" to trigger the "Device Manager" to determine what device to use to contact the user. The device driver may need to massage the body of the message into an appropriate format for the physical device. For example, if the message is text only and the target device is only able to handle audio, (i.e. a telephone), some text to speech conversion must be carried out.

2.2 Personalizing the System

This particular system contains three personal agents: a "Classifier", an "Action Definer", and a "Secretary" agent. The end user personalizes the system by specifying his/her desires to the agents.

2.2.1 Classifier Agent

The "Classifier" agent's role is to look through an incoming message and classify the message into a set of classes as defined by the user. The user can define any number and any type of classes for a message along with a set of rules that helps determine if the message fits the defined class type. These rules take on an appearance similar to the following rules,

DEFINE class_name AS
((attribute [operator] value)
OR (attribute [operator] value).....

AND ((attribute [operator] value)
OR (attribute [operator] value)...)

AND ((attribute [operator] value)
OR (attribute [operator] value)...)
…

In this example, the class_name will be associated with the messages that evaluate the expression after the keyword AS to TRUE. This expression is composed of a number of (attribute [operator] value) sets connected by Boolean operators. The currently available attributes are sender, recipients, number of recipients, date received, number of lines, subject, message body, and other defined classes. The operators available are =, !=, <=, >=, <, >. Obviously not all are applicable to all fields, and the operator meaning can differ.

For example, "number of recipients = 2" means an equality, whereas "body = 'this is an example'" means "body contains 'this is an example'".

2.2.2 Action Definer Agent

The "Action Definer" agent's role is to take a classified message and attach to that message an action to be performed on the message. Specification of the type of action to be performed to the message is similar to that done for the classifier agent, i.e. as a set of rules that map classes of messages to actions. A typical example of a rule has the following form,

IF class_name ACTION (action_1, action_2, ..., action_n).

Which specifies that if a message has been classified as class_name perform actions (action_1, action_2, ..., action_n).

Actions are divided into 2 types: direct and subjective actions. Direct actions are actions that can be resolved directly by the "Device Manager" and require little or no interpretation. These actions can be serviced directly by the "Device Manager". Subjective actions require more interpretation and therefore are processed by the "Secretary" before being serviced by the "Device Manager". Examples of these two types of actions are the following, "phone_me '555-1234'" is a typical direct action, while "contact_me" is a subjective action requiring further interpretation. These more abstract subjective actions are open to interpretation and depend on the particular process and the situation of the user or available inputs.

2.2.3 Secretary Agent

The "Secretary" agent's role is to act upon any of the actions attached to a message. The secretary must first decide the type of action the message has, is it a direct or a subjective action. If it is a direct action then it can be passed directly to the "Device Manager" so it can process the message. If the message has the subjective action then the "Secretary" has to interpret the action. An example of this is the "contact_me" action.

The "contact_me" action requires the secretary to use whatever resources are at its disposal to determine where the user may be. At the moment it uses a unique hierarchical scheduling structure to determine the availability of the user. The scheduling concept uses a 3 tier hierarchical scheduler that represents 3 abstractions of time management. Commencing from a default description of a user's day (9-5 Workday), to a more refined blocked-off scheduled events (10-12 talk, 2-4 meeting), to finally a set of temporary changes which reflect the instant picture of where the user is located (11-12:30 John's Office). The more detailed temporary changes take precedence over the user's scheduled events which in turn take precedence over the default day. This idea is what is shown in the Top View of the hierarchical scheduler shown in Figure 2.

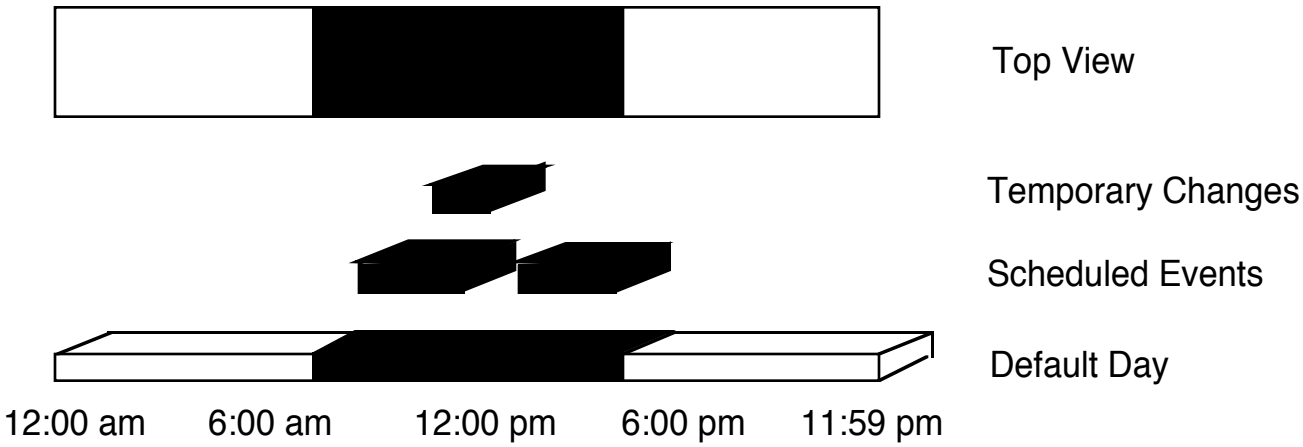

Figure 2. Hierarchical time-management scheduler

3. Implementation and Discussion

The system has been implemented using Lotus Notes as the underlying development environment [6,7]. The system, as currently implemented, can manage both voice and e-mail messages. E-mail messaging is a typical example of asynchronous communications and therefore are immediately stored into the Universal Message Box and processed. If a message is categorized to be immediately delivered to the end-user the system takes the action to actively deliver the message through a pager, a telephone (using text to speech), fax, or forwarded to another e-mail address. Any message that is not categorized to be delivered to the user is kept in the Universal Message Box and can be retrieved, via the telephone or using a client on a workstation. Voice is an example of isochronous communications and is not immediately stored in the Universal Message Box. Instead the incoming call is classified and delivered immediately to a device that can manage isochronous voice communications. If this is not possible a voice message is taken and stored in the Universal Message Box, which now can be manipulated exactly like an e-mail message.

The system is being used at the Seamless Personal Information Networking (SPIN) group at NRC. We feel it is important to use the system on a daily basis in order to evaluate its strength and weaknesses. The Personal Agents are evolving as the system is used in our daily work. Learning how to manage the Class and Action rule databases will require some time. The Classifier and associated filter process will need to be improved and adapted as we learn more about how we ourselves manage our messages. We are actively working on a new implementation of the filter process, one which uses machine learning. This easy replacement of the various modular processes and tasks is one of the major advantage of the architecture we have adopted.

A significant amount of work remains to be done. This version of the system is a prototype that allows us to experiment further either with the modules of the system or the design of the system itself. We also hope to experiment with the delivery of interactive voice to a multi-media equipped workstation. This will involve interfacing speech right to the desktop via a Computer Telephony Integration (CTI) application. We also hope to carry out work in the area of background monitoring for telematics. Background monitoring involves using various sensors, for example, motion detectors or video cameras, to gain information about the user environment, which can be used by the "People Finder"[9].

About the authors

Ramiro Liscano is a Research Officer with the Seamless Personal Information Networking (SPIN) group of the National Research Council. His current research work is in Reasoning with Uncertainty, Multi-Agent System Architectures and Information Filtering. Before joining the SPIN group in April 1995, he was part of the Autonomous Systems Laboratory at NRC working on Sensory Data Processing for Mobile Robot Navigation.

He can be reached at the Institute for Information Technology, National Research Council Canada, Montreal Road, Building M-50, Ottawa, Ontario K1A 0R6.

His Internet address is liscano@iit.nrc.ca

Roger Impey is a Research Officer with the Seamless Personal Information Networking (SPIN) group of the National Research Council. His current research work is Seamless Messaging. Before joining the SPIN group in April 1995, he was part of the Software Engineering Laboratory at NRC.

He can be reached at the Institute for Information Technology, National Research Council Canada, Montreal Road, Building M-50, Ottawa, Ontario K1A 0R6.

His Internet address is impey@iit.nrc.ca

Qinxin Yu was a summer student with the Seamless Personal Information Networking (SPIN) group of the National Research Council. She spent the May-Aug '96 term working with the Seamless Messaging team.

She is currently a graduate student at the University of Toronto, and can be reached at The Department of Computer Science, University of Toronto, Toronto, Ontario, Canada.

Her Internet address is qyu@dgp.utoronto.ca

Suhayya Abu-Hakima is the Group Leader of the Seamless Personal Information Networking (SPIN) group at the Institute of Information Technology at the National Research Council. She has been a researcher at NRC since 1987. She had previously worked at BNR starting in 1982. She has Doctorate and Masters degrees in AI from Carleton University's Department of Systems and Computer Engineering.

She can be reached at the Institute for Information Technology, National Research Council Canada, Montreal Road, Building M-50, Ottawa, Ontario K1A 0R6.

Her Internet address is Abu-Hakima@iit.nrc.ca

References

[1] M. Weiser, "The Computer for the 21st Century", Scientific American, Vol. 265, No. 3, 1991, pp. 94-104.

[2] J. Chattoe, P. Leach, and R. Riesenbach, "Ontario Telepresence Project - Final Report", Information Technology Research Centre, Telecommunications Research Institute of Ontario, March 1995.

[3] R. Buxton, "Integrating the Periphery and Context: a New Model of Telematics", *Graphics Interface '95* , Morgan-Kaufman, New York, 1995, pp. 239-246.

[4] CallXpress3 Product Information Sheet, Applied Voice Technology, Kirkland, Washington, 1996.

[5] The OcteLink Network Service Product Information Sheet, Octel Communications, Milpitas, California, 1996.

[6] P. Gordon, "Message Handling Application", NRC COOP Work Term Report, 1996.

[7] Q. Yu, "Seamless Message Handling Application", NRC Summer Student Report, 1996.

[8] L. Wall and R. L. Schwartz, "Programming PERL", O'Reilly & Associates, Sebastopol, CA, 1990.

[9] Ferguson, Innes A. and Davlouros, James D. 1995. PeopleFinder: A Multimodal Multimedia Communications Tool for Interconnecting Network Users. In Working Notes of the IJCAI-95 Workshop on Intelligent Multimedia Information Retrieval, Montreal, PQ, August