A.I. Solutions in Support of Global Trading

Dr. Robert I. Phelps
A.I. Laboratory, S.W.I.F.T. s.c., 1310 La Hulpe, Belgium

Abstract

S.W.I.F.T. runs a global financial network in support of financial transactions. To increase the level of efficiency and service, the use of A.I. techniques have made a significant impact on S.W.I.F.T. operations. It is perhaps the only example to date where A.I. techniques have had an important impact on a company's core business function. This paper describes the application environment, surveys research and developments which are presently underway and puts them in the context of how the introduction of A.I. technology has been achieved at S.W.I.F.T.

The environment

The various system functions of S.W.I.F.T. II are separated into a well defined hierarchy with each level of the hierarchy being controlled by a particular computer (or series of computers). System management and access security are controlled by one computer, while message processing, routing and safe storage are handled by other computers. Message input processing, validation and output queuing are handled by a number of Regional Processors (RPs).

All of S.W.I.F.T. II's computers are linked by means of a global communications network so that they are in constant communication with each other.

The logical architecture of the S.W.I.F.T. II system follows the general principles laid down by the International Organization for Standardization (ISO) for Open Systems Interconnection (OSI). Use of the OSI Reference Model allows for the logical separation between, for example, the connecting line protocols, system access procedures, network management and the implementation of individual applications.

Each active component of the S.W.I.F.T. II architecture is referred to as a node. Nodes are connected together either by direct cable links, by local and international telephone circuits, by Local Area Networks (LANs) or by satellite circuits, depending on the proximity of those nodes and the volume of traffic which needs to be supported between them.

The S.W.I.F.T. II system nodes are:
- System Control Processor (SCP)
- Slice Processor (SP)
- Regional Processor (RP)
- Communications Processor (CP)

The whole S.W.I.F.T. II system is centred on two manned System Control Centres (SCCs), which are located in Zoeterwoude, near Leiden, in the Netherlands.
and Culpeper, near Washington, in the USA. The SCCs house the two key components of the system, namely, the SCP and the SP.

The SCP monitors and controls the entire S.W.I.F.T. II system. In particular, the SCP controls access to the system by validating all access requests. The SCP itself does not process financial messages.

The S.W.I.F.T. II system is designed to process information in the form of messages. The message switching power of the system (i.e., routing and storage of messages) is provided by a number of Slice Processors (SPs).

The RPs perform input message validation and output message processing. The connections to the S.W.I.F.T. Transport Network (STN) required at a particular RP are provided by the CPs.

Messages for which standards have been developed and which can be sent over the network include:

Category 5: messages which are exchanged among financial institutions involved in security transactions, including trading instructions and confirmations, settlement instructions and confirmations, information about corporate actions and events, capital income advices, statement and portfolio management information;

Category 3: three types of messages exchanged between financial institutions, on behalf of themselves, providing information about the confirmation and settlement of: foreign exchange contracts, i.e., the buying and selling of currencies; the placement of money in connection with loan/deposit business; and forward rate agreements, i.e., contracts between parties which may be seeking to protect themselves against a forward interest rate movement, in the currency of the agreement for the agreed amount, for a specified period at an agreed interest rate;

Category 6: messages sent among financial institutions involved in syndications. These messages deal with the drawdown/renewal of a facility, setting of the interest/exchange rate of a facility and the payment of principal, interest and/or fees due on a syndication.

The S.W.I.F.T. A.I. lab

In S.W.I.F.T., the introduction of A.I. and other advanced software techniques into S.W.I.F.T. systems, operations and products is undertaken by a group of eight full-time persons. The group is distributed between Europe and the U.S. It both carries out internal research, leads project development teams put together from S.W.I.F.T. personnel and external consultants and supervises contract research carried out by commercial and academic organizations. Close contacts are maintained with several academic A.I. departments, notably the VUB (Vrije Universiteit Brussel), where S.W.I.F.T. funds an A.I. Professor, the Turing Institute in Glasgow and Maryland University in the U.S.. Ongoing working arrangements with several commercial groups are also maintained. In addition, S.W.I.F.T. participates in European Community funded cooperative research projects under the ESPRIT programme, presently represented by the EQUATOR project in developing a toolkit for temporal reasoning techniques.

Each year the A.I. Lab runs the International BANKAI Workshop on a specific A.I.-related topic of interest to the financial community, and the proceedings are published as the BANKAI series. [1]

Past A.I. experience in S.W.I.F.T.

Over the past three years, the A.I. group has been involved in five main lines of work. The least successful line has been the development of a prototype to aid banks in preparing and checking certain complex S.W.I.F.T. messages (documentary credits) for transmission over the network. Although the prototype, a combination of expert system reasoning and hypertext interface performed its function, a combination of delivery platform changes, cost benefit doubts and the lack of strong client sponsorship meant that this project was frozen. These are lessons that have been taken into account in assessing possible new applications, and we believe that the last two problems affect many small expert system developments which do not get beyond the prototype stage. As noted below, we have found the best way to successful introduction is from larger scale systems with significant business impact.

Two lines are still ongoing. One is the development of automated production routes from desktop-published S.W.I.F.T. manuals and handbooks to on-line hypertext displays of the same material. To achieve this requires the solution of several problems: text and figures must be reformatted to appear nicely on screen; indexing and hyperlinking must be automatically added to allow easy traversal through the electronic document without swamping the viewer with unnecessary links; navigation facilities must be designed to prevent the user from "getting lost"; graphics must be reformatted; the look and feel and ease of use must be significant improvements on the paper versions; and the whole conversion process must both allow regular updates of material and be able to take place within a few days with virtually no human intervention. This work will be incorporated in the SIRIUS project discussed below.

The other ongoing line is research in the EEC EQUATOR project. This is a 12-partner consortium of European companies collaborating in the development of a toolkit to aid the design of complex systems involving temporal reasoning, and in S.W.I.F.T.'s case, results will
be utilized in our internal network management programmes.

The remaining two lines, which have seen the group's greatest success, both come from the construction of an expert system to manage the S.W.I.F.T. I network, the company's core business functions (now in the process of transferring to S.W.I.F.T. II). The INCA expert system [2] which was designed, prototyped and implemented to control this network over an 18-month period proved a considerable success in two ways. Firstly, it automated receipt of alarms from the network, filtered and correlated them, reached a diagnosis of any problem occurring and took response actions to alleviate the problem, all in real-time. Ninety-seven percent of received alarms can be dealt with without need for operator intervention. By doing so, the size of the operator force needed to control S.W.I.F.T. I was drastically reduced (approx. saving of 50 persons), as well as the quality of control being improved.

The other line of work from this project is that an incremental software development methodology [3] was set up which enabled the project to be on-time and on-budget despite the advanced and experimental nature of software used and the complex nature of the project itself. Furthermore, the finished system could be handed over to S.W.I.F.T.'s software support department where, after training, it has required only one dedicated person to assume responsibility for its maintenance. This software engineering aspect of the project has led to further work described below.

New developments and research in S.W.I.F.T.

This section will give a snapshot of developments and directions being pursued at the time of writing. Although the A.I. Lab is a research group, it must be responsive to the needs of S.W.I.F.T., and so research items may rise or fall in priority over time. The work described below is being actively prototyped at present. It is discussed under four headings: network management, intelligent information provision, software engineering and enabling research.

Network management

As noted in the introduction, S.W.I.F.T. is transferring its service from the old S.W.I.F.T. I network to the new S.W.I.F.T. II network. Although the basic functionality, that of a store and forward message transmission device is preserved, in most aspects including architecture and application software, the new network is completely changed. Thus the INCA system cannot be applied since its event parsing, diagnostic and troubleshooting modules are not valid for S.W.I.F.T. II. At the same time software tools for real-time reasoning have advanced and lessons on design and development have been learnt from INCA.

Thus it was decided to start with a new development environment and produce a superior control system with greater ability to deal with the new, more complex, network. Complexity may be judged by the fact that there are 4000 types of events which can be produced just by the application layer, with many more at vendor architecture and transport network levels. The system, ANDES, should be able to understand and deal with about ten events per second, which can include complex hypothetical reasoning tasks, juggling and resolving several hypotheses in real-time.

ANDES has been designed in three hierarchical layers and the reasoning follows a strict design of object and procedure libraries and formats and a standardized sequence of module interactions in event handling and reasoning. By enforcing this structure, it will be possible for several developers working independently to achieve software consistency and code sharing as well as providing a basis for documentation and simplifying the maintenance task. The three layers will be developed in sequence. First a monitoring layer providing connections to the S.W.I.F.T. II network, receiving and parsing alarms, sending interrogations for further information and displaying a real-time view of the network status to the operators. The interface is graphical in nature and has been designed to provide a high level overview of the system on one screen with indications of network problems and important new alarms received, with the ability to quickly zoom into successively more detailed views of network components and textual information on problems. The second layer will be a diagnosis layer which will filter and reason on the incoming event stream in order to concentrate the operators' attention on underlying problems and advise on their nature and the evidence for the diagnosis.

Finally, the third layer will be the active control layer, implementing responses to problem diagnoses and largely eliminating the need for operator control, freeing them to concentrate on new or unusual problems.

All of these layers rely on the monitoring level keeping a model of the network which is updated in real-time and can immediately map any changes in configuration introduced.

The complete ANDES will provide enhanced quality of control over a complex network with ever-increasing global traffic for financial trading and other banking needs, as well as reducing costs.

Intelligent information provision

We are researching and developing several forms of information integration, presentation and intelligent retrieval in two associated large-scale projects, both of which are helpdesk systems to assist S.W.I.F.T.'s support interface with its users in the banking world. This section will concentrate on the more advanced of these systems,
SIRIUS (S.W.I.F.T.'s intelligent resource for interactive user support).

When calls, faxes or other messages are received asking for information or reporting problems, the user support staff may need recourse to a wide range of information sources. In particular, on-line terminals are available to provide some network status information, phone calls can be made to network operations to check possible problems in the transport layer of the network, information in paper form is needed to advise on the correct way of formatting messages and on the operation of S.W.I.F.T. interface devices, separate databases on different hardware may be accessed and e-mail facilities used, problem reports and solutions are logged in another system. The aim of SIRIUS is to integrate all of this information on one workstation, to provide real time network status information displays, to provide advisory expert system capacity for dealing with queries and to introduce case based reasoning to help in problem solving making use of the problem reports.

To achieve this, several developments are in progress. SIRIUS will make use of ANDES by receiving a display of network component status and by receiving alarms relevant to the users at individual or country level. Certain types of non-fatal alarms will be statistically analysed to provide an early warning to the operators of developing difficulties which may affect groups of users.

The off-line (paper-based) information sources will be integrated into on-line displays. To achieve this a process has been designed to take existing desktop published material intended for paper output and to automatically reformat it for screen display, add hypertext links to allow quick navigation and to allow regular updates to be incorporated in an entirely automatic manner. A.I. pattern searching techniques are involved in analyzing the desktop published texts and understanding their structure. The result is a restructured document allowing quick access to the information regularly accessed by these users.

An expert system facility, APACHE, is being built which can guide a relatively inexperienced operator through a question and answer session with an enquirer. This will contain in-built expertise on common problems and link with the case based reasoner for more sophisticated problem handling.

The records of solved problems will be dispatched to an off-line database on another machine for further statistical analysis. Indexes to those cases will however be retained by SIRIUS and used in the case based reasoning process, allowing relevant past cases to be selected and displayed, on the basis of similarity to a present case. This will have the role of a "corporate memory" whereby each operators' problem solving experience can be utilised by the others. Directed search facilities on this case-base will also be available.

Other utilities will be incorporated, with e-mail, a communal workboard to allow information sharing between operators and language aids to help communication with non native English speakers.

The overall effect is to provide quick and efficient access routes to the necessary information, by providing high level displays of network status, by putting paper information on-line in an easy-to-use form, by developing an expert system to advise on how to obtain and analyse information and by tapping the resource of previous problem solutions by implementing them in the CBR. Thus information access is largely by guidance from the SIRIUS system itself.

Software engineering and maintenance

Like most large producers of software, S.W.I.F.T. has much investment in code which needs to be maintained. In S.W.I.F.T.'s case the code underpins its provision of services for global financial transactions. Approximately 60% of system related effort is directed to maintenance rather than new code development. To improve ease of maintenance cooperative research with the Centre for Software Maintenance in the U.K. is being conducted in the use of formal transformations to restructure both procedures (e.g. loops, calls, go to's and data structures in order to simplify and clarify the code and to successively abstract its functionality into a high level specification. These transformations provably guarantee that the program functionality (output from input) remains unchanged. In the course of the transformation process existing bugs may be found and repaired and redundant code removed. At present the selection of transformations is a largely manual process and the aim of the research is to automate and guide the use of the transformations. This will allow restructuring of older code via forward engineering using CASE tools and allow easier programmer understanding of existing code in carrying out changes.

In addition to this work on maintenance, S.W.I.F.T. has also developed with input from the INCA and ANDES experience, a set of standards for incremental development projects which have been officially adopted by the company and which will give guidance to other groups wishing to adapt this approach to software engineering projects. INCA and ANDES experience has shown that these projects can be tightly controlled regarding budgets and schedules as well as offering development resource reductions compared to classical development methods. The culture which has been built up in these projects, including experience on the use of productivity tools, documentation and control procedures is also available to lend support to other areas of S.W.I.F.T.
Enabling research

The areas outlined above represent major thrusts in the S.W.I.F.T. AI group’s work. Here we briefly mention some of the research issues being studied as enabling technologies to support these and future development projects. Two areas being presently pursued are natural language, in particular machine translation, and neural networks.

In the machine translation area we are working with the TTI group in Washington to evaluate an English to French system which can be taught by example to adapt to particular styles of text and word usage. In S.W.I.F.T.’s case much of the information on interfaces and message formats is written in a standardized style describing e.g. financial transactions, and so is amenable to an approach of achieving quality translation by specialization. A transfer approach to translation is used and teaching is carried out largely at the parsing and target synthesis stages, and involves semantic category information as well as syntactic information. It is also intended to use the experience gained here in the development of natural language database interfaces.

In neural networks, we have experimented with the standard architectures and learning algorithms, as a result of which we have designed a new approach presently being investigated. Our approach is to allow dynamic code generation to code for individual examples presented during training (or untutored learning) and to combine this ART-like approach with a one pass weight update propagation algorithm for enhanced efficiency. This approach is being tested on handwritten character recognition and has potential S.W.I.F.T. application in problem diagnosis and case based retrieval mechanisms.

Conclusions

This paper has presented a snapshot of the more important lines of work being undertaken in AI by S.W.I.F.T. at this time. It provides an example of the impact and penetration that it is possible to achieve in an organization by the use of AI. Success in our experience has been found to occur not by the commonly recommended route of small prototype applications but by large scale systems of real importance to the company’s functioning with concomitant high visibility. We hope our experiences will be of use in encouraging other financial organizations to adopt enthusiastically the opportunities for business impact and efficiency offered by these new “intelligent” technologies.

References


