Mobile Intelligent Agents in Banking

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Abstract: The purpose of this paper is to examine appropriate areas in the *banking sector*, which will benefit by the use of the *mobile agent* technology. Agent suitability is studied based on a classification of banking processes according to operational and strategic criteria. Banking services and processes are described and their susceptibility to mechanisation and improvement by using the agent technology is examined.

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1 Introduction

The purpose of this paper is to examine the suitability of using *mobile agents*, a very modern and promising technology, in the area of *banking*, a very extensive and dynamic business domain, where leading edge information technology is considered a major strategic tool.

Target customer groups for the introduction of advanced computer and communication technologies usually include large businesses, which are capable of paying for the required investment. Banks play a prominent role among large businesses, but their behaviour in accepting innovation is conservative and hesitant.

A bank is usually a large organisation with a long tradition and well established working practices, which generally oppose innovation. It is usually due to the singularity of certain financial transactions, which may require increased security and privacy. For example, there is a belief that "serious" financial interactions require interpersonal communication. It is largely true that negotiation between humans is often necessary and cannot be replaced by an interaction between intelligent software components. Unfortunately the application of new technologies is possible only to the degree they can be automated. However decision-makers in the banking area recognise Information Theory (IT) as strategic enabler and competitive tool.

A traditional software component is always installed in a machine, which supports its operation. A mobile agent [2], [3], [5] is a software component without a required fixed locus of operation. Typically, a mobile agent is initialised and sent off to a remote site in order to perform a specific task asynchronously. In multi-agent systems, pursuing the task involves co-operation, collaboration and negotiation with other software agents. A certain degree of autonomy and intelligence allows the agent to operate also in unpredictable or changing environments.

There are measures to be taken in order to protect the agents against security threats and prevent the hosts against illegal actions performed by the agents [1], [4], [6], [3].

A *service* can be seen as a collection of co-operating software components. A *distributed service* is realised by a set of components, which do not reside in the same machine and thus require a telecommunications infrastructure. While fixed components communicate with each other by remotely exchanging messages, mobile agents can move in order to meet each other in the same machine. By moving around and interacting locally agents can offer the following advantages:

- *Less communication traffic created by remote interaction*: This happens only if the traffic induced by agent transportation is smaller than the traffic created by remote communication.
- *Increased security and privacy by avoiding remote connections*: Information leakage usually happens in communication links, which can be tapped.
- *Increased reliability*: An interaction cannot be interrupted by a communication problem.
- *Circumvention of administrative, security and other constraints*: For example a database may not allow sensitive information to be exported, while it may allow local usage for decision making.

Unfortunately there are disadvantages in this technology, which are concentrated in the security of these systems. Dedicated security services should be accompanied with the agent systems offered by their designers.

In the following few sections a brief description of banking services is given. Then the suitability of using mobile agents for each service category is examined including security aspects.

2 A taxonomy of banking services and processes

The concept of "Business Life-Cycle Stage" will be defined specifically for the banking domain, in order to obtain a broad conceptual grouping of business information needs. The goal of this definition is to scope each Business Life-Cycle Stage so as to have information needs amenable to similar technical treatment. The above concept will serve as the first dimension of the *functional area* definition, as mentioned in Section 1.

The *business life-cycle stage*s are defined by means of interaction of two concepts: *business phase*s and *business activity steps.* The *business phase* is defined as a set of business functions having a common strategic objective. The phases will be considered from the viewpoints of both the customer and the bank. In the banking domain, we recognise the following major three business phases:

Phase 1: ***Marketing***. This phase includes (a) from the service provider's viewpoint, marketing and sales activities (e.g. market research, prospective clientele targeting, promotion etc.) and (b) from the customer's viewpoint, various market searching and shopping activities. Example: marketing campaign to attract prospects for a new consumer loan-banking product, prospect contacting and receipt of loan applications.

Phase 2: ***Evaluation & decision.*** This phase includes (a) from the service provider's viewpoint, activities for the risk evaluation of the prospective business case in order to support the decision of whether to collaborate or not and (b) from the customer's viewpoint, activities aiming at the cost/ benefit analysis required to support the same decision. This phase, as a matter of rule, follows the marketing phase. Example: credit scoring of received applications for the aforementioned consumer loan-banking product, evaluation of application scores, approval/ rejection decision per application.

Phase 3: ***Service provision.*** This phase includes activities that support the performance of business transactions in order for the service provider/ customer to deliver/ accept the financial products/ services decided in phase 2, at the agreed prices and according to the agreed terms. Example: disbursement of loan principal to the customer via direct credit of a customer's deposit account; payment of monthly instalments via direct debit of a customer's deposit account.

The *business activity model* is defined as a generic elementary pattern to which business activities in the banking domain usually comply. The activity model will be considered from the viewpoints of both the customer and the service provider (i.e. the bank). We recognise the following major steps of the business activity model, which are illustrated in Figure 1.

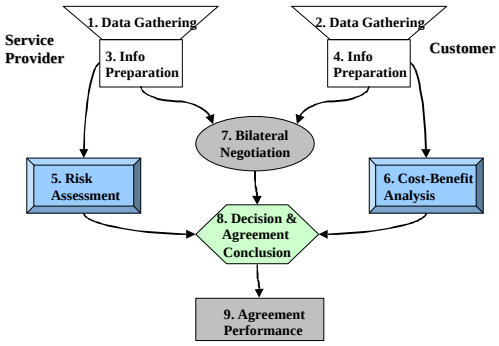

Figure 1. Business activity model

Step 1: *Data gathering (service provider)*. This step includes the identification and gathering of primary raw data on customers relevant to a business phase. Example: data collection on prospective customers for a consumer loan product.

Step 2: *Data gathering (customer)*. This step includes the identification and gathering of primary raw data on service providers relevant to a business phase. Example: data collection on consumer loan product offerings (pricing and terms) by various banks.

Step 3: *Information preparation (service provider)*. This step includes the sorting, filtering and consolidation of gathered data on customers relevant to a business phase. Example: collection of information needed to support customer applications for consumer loan.

Step 4: *Information preparation (customer)*. This step includes the sorting, filtering and consolidation of gathered data on service providers relevant to a business phase. Example: draft agreement with offered pricing and terms of consumer loan, for which an application has been submitted.

Step 5: *Risk assessment (service provider)*. This step includes the measurement of estimated financial risk associated with a candidate customer agreement. Example: credit scoring of a consumer loan application based on objective predefined rules and criteria ("score cards", "scoring algorithms").

Step 6: *Cost-benefit analysis (customer)*. This step includes the measurement of cost and of estimated benefit related to a candidate agreement with a service provider. Example: Calculation of total interest payable over the term of a consumer loan.

Step 7: *Bilateral negotiation (service provider & customer)*. This step includes the negotiation between the two parties in order to come up with a commonly agreed set of business terms relevant to a given financial product/ service. Example: negotiation between loan officer and applicant about the interest rate and the terms of a consumer loan.

Step 8: *Decision & agreement conclusion (service provider & customer)*. This step includes the business decision (made by both parties) to collaborate and the conclusion of the agreement that will govern the collaboration. Example: approval of the loan and signature of the loan agreement between customer and the bank.

Step 9: *Agreement performance (service provider & customer)*. This step includes the performance of the business transactions related with the actual delivery of a financial product/ service, as specified in the related agreement. Example: Disbursement of loan principal to the customer, payment of monthly instalments by the customer.

Meaningful combinations of business phases and business activity model steps define the *business life-cycle stages*. In a broad and generic conceptual approach, we have recognised eleven such stages, denoted by the labels "**L1**"-"**L11**" in Table 1:

ACTIVITY MODEL STAGES	phase 1 *Marketing*	phase 2 *Evaluation & decision*	phase 3 *Service provision*
1. Data gathering (service provider)	L1		
2. Data gathering (customer)	L2		
3. Information preparation (service provider)	L3	L5	
4. Information preparation (customer)	L4	L6	

5. Risk assessment (service provider)		L7	
6. Cost-benefit analysis (customer)		L8	
7. Bilateral negotiation (service provider & customer)		L9	
8. Decision & agreement (service provider & customer)		L10	
9. Agreement performance (service provider & customer)			L11

Table 1. Business life cycle stages

2.1 Financial instrument categories

The concept of *financial instrument category* will be defined specifically for the banking domain, in order to obtain a broad conceptual grouping of the most common banking products and services offered by a bank to the large bulk of its clientele. The goal of this definition is to scope each financial instrument category so as to have information needs amenable to similar technical treatment. The above concept will serve as the second dimension of the functional area definition, as mentioned in Section 1. Table 2 presents concisely the above concept, outlining (for each category) the main banking products and the corresponding major strategic issues.

CATEGORY	BANKING PRODUCTS	STRATEGIC ISSUES
Deposits	Deposits: Demand (savings, current) and term, repos	Instruments: source (attraction) of funds. Success factor: volumes versus cost of attracted funds.
Loans	Loans to individuals: housing, consumer, credit cards, etc. Loans to corporations: open credit/ overdrafts capital investment loans, construction loans, etc.	Instruments: use (occupation) of funds. Success factor: volumes versus risk management.
Trade Finance	Letters of credit, letters of guarantee, bills of exchange	Mediation instruments. Success factors: volumes versus operational costs & risk management.
Stock/bond market investment	Stocks purchasing/ liquidation, retail underwriting, stock-based mutual funds, fixed income securities (treasury bills, bonds), bond-based mutual funds	Mediation instruments. Success factor: volumes versus operational costs.
Payment services	Third party payments (direct debits and standing orders), retail foreign exchange, retail funds transfer.	Mediation instruments. Success factor: volumes versus operational costs, speed of transfer, secure protocols.

Table 2. Financial Instrument Categories

3 Functional areas and agent suitability

3.1 Agent suitability rating

A *functional area* has been defined as a set of business processes pertaining to a financial instrument category and having a common operational objective. Functional areas are defined on

the basis of the combination of the *business life-cycle stage* dimension (described in Section 2) and the *financial instrument category* (see Section 2.1).

Table 3 presents the functional areas (denoted by "cells" in the Table), as well as their characterisation as to the suitability of using intelligent mobile agents by means of the following denotations. In Table 3 a *dark grey cell* designation means that agents are a promising technical approach for increasing effectiveness and efficiency in the given functional area, as regards the satisfaction of its information needs. A *light grey cell* designation means that agents can be used beneficially to satisfy certain information needs in the given functional area, but the significance of the related benefits depends on specific business and technical factors, which cannot be easily conceptualised/ generalised. A *white cell* designation means either that the information needs of the given functional area are not amenable to automated treatment, or that agents do not impart any considerable advantage over traditional software technologies to the given functional area.

	Financial Instrumental Categories				
Business Life-Cycle Stages	***1.Deposits***	***2.Loans***	***3.Trade Finance***	***4.Stock/ Bond Market Investment***	***5.Other services***
L1					
L2					
L3					
L4					
L5					
L6					
L7					
L8					
L9					
L10					
L11					

Table 3. Functional areas and suitability of agents

3.2 Suitability of agents in functional areas

In this sub-section a justification for the ratings presented in Table 3 is given by following the life-cycle stage taxonomy defined in Table 1.

3.2.1 Stages **L1** and **L3** -*Data gathering performed by the service provider in the marketing phase and pre-selection.*

The essence of these functional areas is *electronic market research*. This research is based on the collection of spatially distributed data pertaining to prospective customers. The above data can be gathered in two ways:

(a) *Querying of humans*, i.e. travelling questionnaires posing structured questions and awaiting responses

(b) *Automatic data acquisition* from publicly accessible databases of prospective customers (e.g. data on financial behaviour) or from publicly available information located in the customer premises (e.g. data stored in one's terminal).

A precondition for the above approach is the availability of a broad list of prospective clients, on which the market research will be targeted. The mobile agents can be used to support both the travelling questionnaire and the automatic data acquisition methods.

Financial Instrument Categories 2 and 3 (and also 4 to some extent) are the ones for which banks usually perform market research. However, as competition in the banking sector keeps intensifying and as technology facilitates the mechanisation of operations, market research may be carried out, at least for the potentially lucrative market segments, even for Categories 1 and 5. The potential advantage of agent usage large depends on the specific application.

The essence of L3 functional areas is electronic market research (as described in L1) combined with *prospective customer pre-selection*. The technical advantage of this combination is to exploit the mobile agent's ability not only for primary data gathering but also for "on-site" decision making. Financial Instrument Categories 2 and 3 are the ones for which banks are most likely to combine data gathering with prospect pre-selection, since risk assessment is a major success factor to them.

Example 1 – *An intelligent questionnaire.* An intelligent questionnaire modifies the questions presented to a client according to the answers received. A sophisticated logic and user interface may be used. The remote call (non-agent) solution implies that the client answers the questions one by one remotely, while the logic (i.e. the choice of questions) is implemented in the service provider's premises. By using a mobile agent the questionnaire is temporarily downloaded in the client's terminal. If the latter is connected to the network relatively slow line, a delay between an answer and the next question is likely to appear in the remote call case. In the agent based solution an agent transportation delay appears, which may be greater than the total delay of the non-agent solution. However, if there is a possibility of an off line (i.e. before the client answers the first question) agent transportation, the delay apparent to the client will only depend on the speed of the local machine executing the questionnaire logic and will probably be negligible. Therefore from the user's viewpoint there is a possibility of improving the response time in a real time application.

The total communication cost depends on the decision and data compression capability of the agent. If answers are processed centrally, each client's answers can be suitably compressed and sent to the questionnaire originator. Note that the compression algorithm can be customised for the specific application. If the agent can reach a decision locally, it can transmit (or port) back only the final (often binary) decision.

Reliability can be associated with the interruption probability of the answering process. Although the local terminal can fail for a number of reasons, remote communication is more liable to break down and produce an interruption episode. Since the answering process will start after the agent has been completely and safely been transported in the terminal, the interruption probability is drastically reduced.

Security can be enhanced in different ways. Since agents essentially are easily downloadable software components, which can be tailored to the specific application, the agent under discussion may implement a customised encryption scheme.

By using specially constructed and certified agents private data can occasionally be used in a decision process without exporting the data out of the client's premises. For example, a specially designed agent can be capable of reaching a decision on whether a client shall be given a loan

based also on the annual income of the client, but the agent need not transmit back the exact income figure.

3.2.2 Stages **L2** and **L4** -*Data gathering performed by the customer in the marketing phase and pre-selection.*

The essence of these functional areas is *electronic shopping*. The data gathering needed for shopping is based on the collection of spatially distributed data pertaining to services offered by various providers. The above data can be gathered in two ways: (a) querying of humans, i.e. "travelling questionnaires" posing structured questions and awaiting responses and (b) "automatic data acquisition" from publicly accessible databases of service providers (e.g. data related to prices and terms of offered products and services). Preconditions for the above approach is (a) the availability of a list of service providers, on which the shopping effort will be targeted and (b) the availability in the market of ready-made packaged software to cover the aforementioned functionality. The Mobile Agents can be used to support both the "travelling questionnaire" and the "automatic data acquisition" methods.

The feasibility and effectiveness of electronic shopping would be greatly enhanced by the presence of *brokers* in the market. Financial Instrument Categories 1 and 2 (and possibly 3 to some extent) are the ones for which customers usually perform shopping.

The essence of L4 functional areas is electronic shopping (as described in L2) combined with *pre-selection (short-listing) of providers' offerings*. The technical advantage of this combination is to exploit the Mobile Agent's ability not only for primary data gathering but also for "on-site" decision making. Financial Instrument Category 2 (and also to a lesser extent 1, 3 and 4) are the ones for which prospective customers are most likely to combine data gathering with short-listing of offerings.

Example 2 – *Brokerage for banking services.* A broker can act as an intermediary between a client and a bank, in order to make sure that the client will buy the best banking product (e.g. a loan) under the most favourable terms. However a broker's agents cannot access the information required to make a selection, unless banks create a specific banking service promotion infrastructure in their premises or in the premises of a third party information provider. The increased security, reliability and privacy considerations mentioned in Example 1 applies here as well. Privacy in this context means that certain bank sensitive data cannot be distributed. Moreover, the accuracy of information provided to agents must be guaranteed, especially if supplied by a third party information provider.

3.2.3 Stage **L5** - *evaluation of a pre-selected potential customer.*

The essence of L5 functional areas is the *collection and processing of information* useful for the evaluation of a pre-selected potential customer. The technical advantage of this approach is to exploit the mobile agent's ability to process data "on-site" for information preparation and decision making. Financial instrument Categories 2 and 3 are the ones for which banks are most likely to carry out information preparation for customer evaluation, since the risk assessment of a potential customer requires the acquisition of supporting data. The privacy considerations mentioned in relation with L1 and L3 are particularly important for this area. Some of the data required for customer evaluation are likely to be collected from public or semi-public databases, which allow a restricted set of questions.

3.2.4 Stages **L6**, **L7**, **L8** – *information evaluation, cost-benefit analysis (client), risk assessment (bank).*

The use of mobile agents in L6 and L8 functional areas does not impart any considerable advantage over traditional software technologies. The data that are necessary for the potential

customer to evaluate the offering of the bank are provided readily on the bank's initiative and the analysis takes place in the client's premises. Cost-Benefit Analysis (L8) is carried out by means of software applications operating at the Data Centre of the potential customer and all the necessary input information has already been gathered/ prepared in previous stages. The close interaction between L8 and negotiation (L9) makes the usage of agents even more unlikely. Mobile agents can be used only if the cost-benefit analysis process is mechanised to a level sufficient for taking a final decision, so as to merge pre-selection with final decision. Risk Assessment (L7) is carried out by means of software applications operating at the data centre of the service provider and all the necessary input information has already been gathered/ prepared in previous stages.

3.2.5 Stage **L9**, **L10** – *Bilateral negotiation and agreement.*

These functional areas are not amenable to mechanisation, since negotiations and business decisions are areas that rely mostly on human interaction and judgement. The related gap between artificial and human intelligence is not likely to be filled soon. Although agents cannot be used in the negotiation and decision process per se, they are likely to be used in contract signing as a means of providing both a specialised user interface and increased security.

3.2.6 Stage **L11** – *Agreement performance.*

The suitability of agents in this stage is entirely service specific and no general conclusion can be drawn. For example, a data-monitoring agent can be installed in the bank premises in order to see whether certain conditions hold and notify the client if a particular condition is occasionally met. The symmetric situation (i.e. a bank's agent in the client's premises) is also conceivable, but a special agreement may be needed.

4 Conclusions

Banking services, processes and products are defined and analyzed in order to examine the suitability of the mobile agent technology in every banking sector. It is concluded that this technology may improve the performance of various banking stages. This paper involves two main steps: (I) Partitioning of the business domain into *functional areas*, based on the two dimensions, the *business life-cycle stage* and the *financial instrument category*. (II) Estimation of the degree of suitability of agents in each *functional area*, based on experiential knowledge of the relevant business functionality needs. The paper attempts a breadth-first initial coverage of this vast and relatively unexplored topic, aiming to provide motivation and orientation for further in-depth research.

5 References

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