Retail banking optimization system based on multi-agents technology

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Abstract: Paper analyzes optimization scopes of electronic systems involved in retail banking and presents an approach to cash management and support system for automatic teller machine (ATM) network. This approach is based on an agent oriented technologies. According researches we described most suitable system architecture for ATM cash management and support system. Different software platforms and agent technologies implementation practice analysis show, that in case of using agent technologies (for ATM network in banking market) the best solution is J2EE and JADE (multi-agent platform) technologies. The paper describes the application of ATM network management and support system based on agent technologies.

Key-Words: Retail banking, ATM, Electronic services Optimization, Agent technologies, Multi-agents, Agent oriented systems, Artificial intelligence.

1 Introduction

A number of market changes are impacting the way how independent sales organizations manage their ATMs and the cash that circulates inside them. Industry consolidation, dropping per-ATM transaction volumes, fluctuating interest rates and new guidelines from the government are all taking their toll [6]. The cost of cash has represented the largest single category of ATM operating expense consistently year after year. Some banks typically maintain as much as 40% more cash at their ATMs than what's needed, even though many experts consider cash excess of 15% to 20% to be sufficient. Cash-related costs represent about 35-60 % of the overall costs of running an ATM [8]. Unfortunately, tracking and cash-balance optimization at ATMs and branches is often less than desirable. The central challenge facing ATM cash optimization is balancing the cash level with the number of cash-out situations. A 40 percent or higher rebank level may be acceptable, if the goal is to be absolutely certain the ATM never ever runs out of cash. Using cash management optimization, real-time tracing and efficient cash loads routing, banks can avoid of stuck ATMs with cash and mange the system in dynamically changing environment by fulfillment the different needs of ATM network participants.

By the end of 2006 the BS/2 - one of the companies of Penki Kontinentai, UAB corporate group – received financial support from the EU structural funds for development of algorithms and software for ATM network management and optimization. In this paper we present first results in solving this task considering software architecture decisions and structure.

This paper is structured as follows. In section 2, wide problem and short notices from our ATM cash management and support services research are presented. In section 3 other agent oriented software implementation in industry are presented. In section 4, the paper describes results of electronic services optimization considering retail banking; according empirical study main types of electronic banking services systems and optimization objectives for such systems are defined. In section 5, software for cash management and optimization in retail banking are analyzed. In section 6, retail banking optimization system functionality is described (*for ATM network*). In section 7, retail banking optimization system platform based on multi-agents technology for automatic teller machine (ATM) network are described. Finally, the main results of this work are discussed in section 8, followed by conclusions and future work.

2 Problem Formulation

To build a model that matches reality as accurately as possible requires gathering information about different operations and processes from documents and company databases, as well as eliciting and formalizing knowledge from domain experts [5]. During the project fist stage (scientific researches) we had interviewed banking sector participants and experts. We made analysis exploring different ATM network support scenarios those are implemented in markets of Europe, Asia and America. According our analysis we founded that ATM network support and cash management has thirteen different scenario models. After analysis of scenarios we found that typical ATM network services provision in banking market consist of nineteen different roles. Not all of roles can influence ATMs network support and optimization. The roles which can' not influence ATMs network support and optimization are internet provider, electricity provider, ATM place owner, ATM implementer, insurance provider, cleaning service provider, ATMs seller. The roles that have different interests and influencing ATMs network support and optimization services are service provider (*bank*), owner of money in ATMs, owner of ATM network, owner of ATMs, corporate net owner, owner of monitoring, owner of communication (corporate net owner), corporate net supporter, in-cassation provider, ATM software supporter, ATM hardware supporter, ATM exploitation provider. The ATMs cash and support management system should incorporate different participant's needs and should have capabilities to be configured and managed in thirteen different scenarios. The information technology systems of participant's can be distributed in geographical manner. The ATM cash and support management system is complex and intended to change dynamically, because there are nineteen different participant involved in ATM network services provision and support, the needs are changing dynamically between them. ATM network cash management and support require agent solutions because of their ability to dynamically adapt to changes in the environment and thus to offer real-time optimization. From such kind of system can benefit not only services providers but also end-users of ATM services. ATM cash management and support system based on agent technologies could increase ATMs services availability, expand services integration and improve usability. ATM network could provide not only cash withdrawal services but also insurance, different fees payments and ect. In this case ATMs terminals become more complex, so does the cash-management process. Keeping track of what is coming in and going out requires constant monitoring and more dynamic and thorough predictive analysis. An agent technology helps to solve information collection and routing (*cash and data*) problems in dynamic systems. A computational intelligence method ANN (artificial neural networks) solves cash forecasting problems. The general idea behind the use of ANN in cash forecasting is to allow the network to map the relationships between various factors affecting the cash withdrawal and the actual cash withdrawal. Using an optimization algorithm, the optimal cash upload for ATM is estimated [8]. The ATMs cash management optimization will be made sensible, via combination of agent technologies and ANN methods capabilities.

3 Demand for agent oriented software in industry

Agent software technologies are currently still in an early stage of market development. Many observers see agent technologies as currently being in this chasm phase of development: adopted eagerly by enthusiasts of new technologies who share the vision, but not yet taken up by the majority of potential users who tend to be more pragmatic about new technologies [4, 10]. Agent technologies have been deployed in some of industrial sectors to solve very specific problems. Applications includes: automated trading in online marketplaces, such as for financial products and commodities; simulation and training applications in defence domains; network management in utilities networks; user interface and local interaction management in telecommunication networks; Schedule planning and optimization in logistics and supply-chain management; control system management in industrial plants, such as steel works; and simulation modeling to guide decision-makers in public policy domains, such as transport and medicine, e.g., see more at [5].

The domains to which agent technologies are most suited are those involving interaction between entities from more than one organization [5]. ATM network cash and support management needs to be automated in order to realize different system participants needs, require the participation of the companies active along that service provision cycle, so that implementing a successful agent-based application requires agreement and coordination from multiple companies.

4 Electronic services optimization considering retail banking

Retail banking taking part in different electronic services networks by implementing end-user or

broker (*cashier*) terminals and technology for costumers. There are different problems for electronic services networks optimization. According empirical study we will present the main types of electronic banking services systems and points out optimization objectives for such systems.

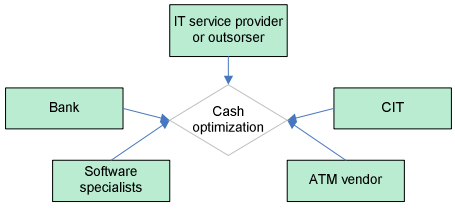
Table 1 Electronic banking services systems types and objects for optimization

System type	Description and problems	The object for optimization
Services systems with the participation of the banks operators	Bank information system makes possible points of services connect remotely, it's makes possible the large collection of bank services in the places convenient for the clients: supermarkets, places of leisure, stations and airports, business centers, commercial centers. The quantity of such points can reach several hundred for the average banks and several thousand for the large one. Such service points work with cash (money processing in accounts, currency exchange, acceptance of payments), and clearing.	The object for optimization can be: a quantity of cash issued for the work to operator, the frequency of left cash collections and replenishment of the necessary currency, the hours of the work at the point of services, the nomenclature of the proposed products (*on the large services system overload remove the most unfavorable products, on the small overload add most claimed*), a quantity and the positioning of the service points (shut unprofitable, add of new with the larger work-load of those existing).
Services systems without the participation of the banks operators	For the continuous care of clients (24 hours 7 days per week) the majority of banks implementing self-service systems which are realized in the form of ATM's network's (automatic teller machine), network of the self-service terminals, Internet-banking systems and mobile-banking systems, etc. The most developed at the present moment are networks of ATM's. However, a rapid development of other information technologies systems and growing cashless payments part influencing use of mobile-banking (use of a cell phone as the means of payment) and internet-banking.	The object of optimization in the networks of ATM's can be cash management, a change in the functionality, the replacement one type of ATM's by others, removal ineffective ATM's, the installation of new ATM's in the most loaded services points, a changes in services process flows and others.
Service systems with participation of cashiers at the points of goods sale and services	Today the most developed network of the bank (receiver) is network of cash payments collection for goods and services directly at the points of sale (**POS**). The functionality of this network grows - the diagram of loyalty, delivery of cash (**cash of back**), and sale of electronic products (codes for filing GSM phones accounts, e-tickets, and vouchers).	The object of optimization in the POS networks can be cash-management (cash- in safe), change in the diagram of connection (dial-up, TCP/IP, GSM), control of functionality, change in the type of terminal (standalone EFTPOS of terminal, PIN Pad + OF ECR, mobile EFTPOS of terminal).
Service systems without participation of cashiers at the points of goods sale and services	The systems processing payments without participation of cashiers become most claimed for example at the servicing stations, in the parking automats, in the automats on sale of piece goods (vending machine), sale of chips in the casino, etc.	The object of optimization in these networks can be a change of the functionality in the dependence on the load, optimization according to the connection, optimization of functions cash- in and of cash of out (if they are included).

We described four electronic banking services systems types and in next paper chapters we will be analyzing services systems without the participation of the banks operators. We will describe system architecture for ATM network cash management.

5 Software for Cash Management and optimization in retail banking

Their strategies differ in the vertical integration of the services they provide.



*CiT – cash in transit, IT – information technology provider, ATM – automatic teller machine;

Fig 1. Participants of retail banking cash optimization process

Table 2 ATM cash management systems comparison

Feature/System*	PCA	OptiCash	iCom	Siemens	GTM Cash Master
Single CP (cash point)	Yes	Yes	Yes	Yes	Yes
Multiple location	Yes	Yes	No data	Yes	No data
Location	Yes	Yes	Yes	No data	Yes
Multiple CP as one location (single CP may run empty)	No	Yes	No data	No	No data
CIT route planning	No	No	No data	No	No data
Stamp and coupon Forecasting	No	Yes	No data	No data	No data
Considering weather forecast	No	No	No	No	No

*Wincor Nixdorf (PCA); Transsoft Inc.; Carreker (OptiCash), Own development; Siemens (iCom); GMT Corp-Workforce Management optimization software (Cash Master)

Offers comprise core applications that focus on tapping maximum savings potential by reducing cash inventories, software products with core applications built on a mathematical concept and enhanced with additional functions to support the cash provisioning process and, finally, integrated service providers who assume responsibility for management of the entire cash provisioning process within the framework of outsourcing.

Basically, providers can be divided into three groups: software providers who focus on inventory optimization; software providers who specialize in cash management; cash management services with the software as part of overall services.

The cash management applications accessible in market as commercial products are only "one entity" based systems, capable to provide functionality for cash management centre. The applications do not have automatic CiT route planning (*cash in transit or cash loading plans*). Such kind of systems could not fully solve ATM cash and support management problems (*comparing to required functionality described in sixth section*).

6 Retail banking optimization systems functionality description

Optimal cash management and services availability is one of the most important factors in the ATM network services business. ATM software support companies implement computer-based tools for cash prognosis and cash loading routes planning of the ATM network both at a strategic level and for short-term optimization. Traditional ATM cash optimization and management software solutions are able to automatically create cash loading plans, describe or make prognosis on cash need, but cannot adequately handle unexpected events and produce the necessary plan deviations in real-time. In cases of last minute changes of cash withdrawals amounts or unexpected unavailability of ATMs due to technical or environment problems, breakdowns or accidents, static planning systems cannot be used, and human effort is needed to adapt the dispatch plans and control their execution, to make services available all the time. This is because these planning systems are designed for relatively stable and not overly complex ATM networks. Planning systems need to find optimal routes and cash load amounts for single ATM, in response to cash demand at end-user points. Cash load orders contains information about the location were the ATMs are, the amounts of cash to load, and the time window need to load cash and make services on ATMs. The challenge lies in the timing associated with the transportation schedule, and the amounts — how much to load cash on an ATM and how much ship out to a branch (*if cash-in, cash-out ATMs are used*) — have a big impact on optimizing cash holdings and taking advantage of the interest that can be earned. System automatically does the analysis (*using ANN*) and then generates a daily report to show cash managers which ATMs are running low on cash. The solution model calculates how much cash should be brought to the ATM for the next load.

7 ATM network management and support system based on agent technologies

This section describes the application of ATM network management and support system based on agent technologies. If we want to create ATM cash management system based on agent technology we will have to identify standard based technologies for communication, data access and programming models.

7.1 Multi-agent system platform

Platform should have widespread toolsets, be acceptable in industry and also should be capable to run from banking enterprise level computing systems. According our analysis there are four potential chooses: CORBA, Java/J2EE, Microsoft .NET or to build own solution.

Table 3 ATM cash management systems comparison

	Characteristics	Advantages	Disadvantages
CORBA	Distributed object computing model; IDL object interface definitions; Services for discovery, persistence, security, events, etc.; Multilingual, Multiplatform; Provides infrastructure for J2EE;	Multilingual; Multiplatform; Relatively lightweight; Good performance on infrastructure applications;	Integration required; Not primary programming model in industry; The technology is losing touch in the market (not perspective);
J2EE	Component model for client (JavaBeans), Web (Servlet/JSP), application components (Enterprise JavaBeans); Synchronous/ asynchronous communication models; Java Only; Container hosts executing components; Provides lifecycle, persistence, security services; CORBA underpinnings for	Industry momentum; BEA, IBM, Oracle, Borland, Sun, etc; Integrated solution; Available on many platforms; Numerous tools; Clear programming model; Ubiquitous access to data	Inflexible programming model; Heavyweight infrastructure; Java technology only; Can be costly;

	interoperability; Frequently used for Web Services implementation;	(via connectors); Internet centric; Clustering/Failover solutions;	
The Microsoft .NET Solution	High level programming model; Extensive toolset; Multilingual; Synchronous/Asynchronous communications models; Varied data access;	Simple programming model; Multilingual; Extensive Web Services integration;	Single vendor solution; Relatively new, immature; Targeted to Microsoft OS platforms; "Rental" licensing;

From this short analysis we can point-out that the best suitable platform technology to create ATM cash management system is J2EE, because: of capabilities to work on different platforms, it is very important for distributed systems; numerous of tools; clear programming model. CORBA is suitable less because of integration requirements, position in market. Microsoft .NET Solution is too risky because it is single vendor solution, immature and targeted to Microsoft OS platforms. Building own solution is too expensive.

7.1 System platform description

Agent systems theory describes agent as entity whose state is viewed as consisting of mental components such as beliefs, capabilities and commitments. Object oriented approach views computational system as modules each of which performs specific task. Agent oriented approach models machines in terms of mental state which consists of beliefs, capabilities and decisions [7]. Objects can only perform tasks they are defined for. One agent can evolve other agent - give it capability to perform some task it could not have been able to perform otherwise. Agents not only show all the properties shown by objects, but also some additional properties like social and proactive behavior [9]. It makes them capable work in highly distributed and complex systems, providing knowledge sharing. Agent's technologies have advantages against object oriented technologies, when system is distributed and complex, because of dynamic changes and involvement of many different interests' parties. JADE will be used to realize agent capabilities for ATM cash and support management system. JADE provides the basic services necessary to distributed peer-to-peer applications in the fixed and mobile environment [1].

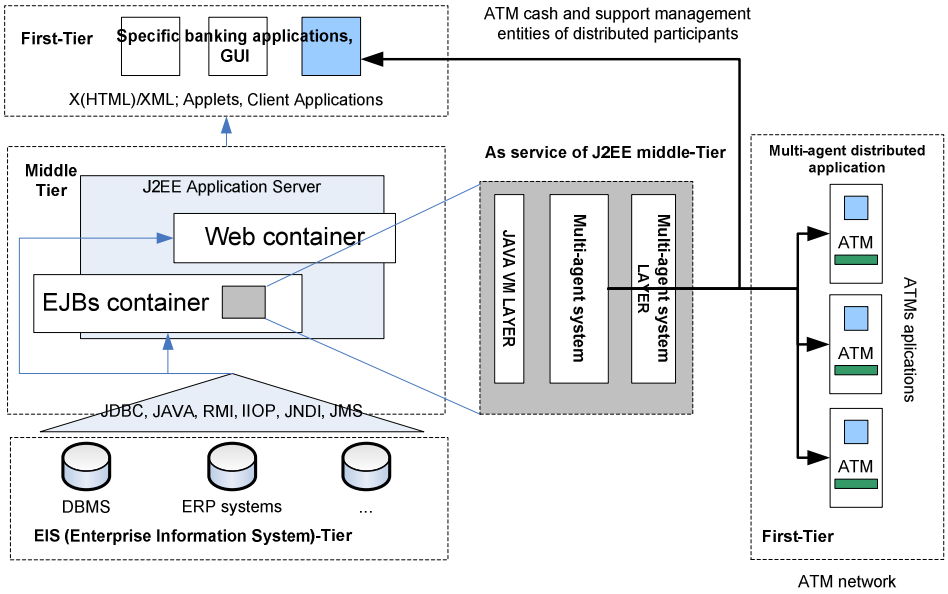


Fig.2 Architecture of ATM network management and support system based on agent technologies.

JADE allows each agent to dynamically discover other agents and to communicate with them according to the peer-to-peer paradigm. From the application point of view, each agent is identified by a unique name and provides a set of services. It can register and modify its Services and/or search for agents providing given services, it can control its life cycle and, in particular, communicate with all other peers. JADE is extremely versatile and therefore, not only it fits the constraints of environments with limited resources, but it has already been integrated into complex architectures such as **.NET or J2EE** where JADE becomes a service to execute multi-party proactive applications [1].

The core platform of the system will be realized using J2EE technology. The J2EE application model

defines architecture for implementing services as multi-tier applications and delivers the scalability, accessibility, and manageability. The J2EE application model provides the benefits of Write Once, Run Anywhere™ portability and scalability for multi-tier applications. This standard model minimizes the cost of developer training while providing the enterprise with a broad choice of J2EE servers and development tools [3]. J2EE and JADE stands for main tool to realize ATM cash management and support system.

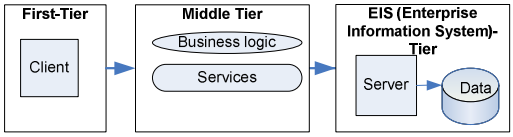


Fig. 2 Multi-tier applications [3]

So in the model [Fig. 2] multi-agent system is presented like a service of J2EE thought Enterprise JavaBean™ components. According D. Cowan researches agent platform should correctly be viewed as simply one of many Services offered to the enterprise application developer. [2].

The major benefit of the J2EE application model is in the middle tiers of multi-tier applications. In the J2EE platform, middle-tier business functions are implemented as Enterprise JavaBean™ components [3]. These enterprise beans allow service developers to concentrate on the business logic and let the EJB server handle the complexities of delivering a reliable, scalable service [3]. ANN prediction system is combined as service of "ATM network management and support system" platform in middle-tier. Optimization rules are described in the business logic component. ATMs in the model [Fig. 2] are shown as multi-agent distributed applications (*in first-tier or client tier*). These applications will be responsible for collecting real-time data. Some relevant data for optimization and cash management will be collected from distributed ATM network participants, like cash management centers, replenishment providers, ATM software and hardware support companies, ATM exploitation provider, processing centers and so on.

8 Conclusion

The future researches will be directed on business logic implementation by considering BDI [11] (***B**eliefs, **D**esires and **I**ntentions*) software agent's capabilities exploration and integration into ATM cash management and support system.

The analysis of technologies capabilities for solving implementation problem of ATM cash and support management system showed good results – were are mainstream technologies to implement agent oriented systems (*J2EE, JADE*), but for practical implementation of the proposed system further experimental investigations are necessary.

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