Multi-Agent System of Samara Region Social Services based on Social Passports and Smart Cards of Citizens

Vladimir Vittikh
Institute for the Control Problems of Complex Systems
61 Sadovaya St.
Samara, 443020, Russia
Tel.: +7 846 333 27 70
vittikh@iccs.ru

Elena Gritsenko
Ministry of Health and Social Development
44 Revolutionnaya St.
Samara, 443054, Russia
Tel.: +7 846 334 33 00

evelina@mskill.ru

Oleg Surnin
SEC "Knowledge Genesis", Ltd.
221 Sadovaia St.
Samara, 443001, Russia
Tel.: +7 846 22 199 41
surnin@kg.ru

Petr Skobelev
MAGENTA Technology
1a Osipenko St.
Samara, 443010, Russia
Tel.: +7 846 270 66 85
skobelev@magenta-technology.ru

Denis Volhoncev
SEC "Knowledge Genesis", Ltd.
221 Sadovaia St.
Samara, 443001, Russia
Tel.: +7 846 22 199 41
agro@kg.ru

Maxim Karavaev
SEC "Knowledge Genesis", Ltd.
221 Sadovaia St.
Samara, 443001, Russia
Tel.: +7 846 22 199 41
maxoid@kg.ru

Mihail Shamashov
SEC "Knowledge Genesis", Ltd.
221 Sadovaia St.
Samara, 443001, Russia
Tel.: +7 846 22 199 41
shamashov@kg.ru

Alexander Tsarev
SEC "Knowledge Genesis", Ltd.
221 Sadovaia St.
Samara, 443001, Russia
Tel.: +7 846 22 199 41
tsarev@kg.ru

ABSTRACT

Paper presents multi-agent system for social services based on social passport and smart cards of citizens. It describes developed approach based on agents and ontologies, architecture of the system and its specific features. It is shown that application of multi-agent technology can bring high value and clear benefits for clients in full scale regional e-government systems.

Categories and Subject Descriptors
I.2.4 [ARTIFICIAL INTELLIGENCE]: Knowledge Representation Formalisms and Methods – semantic networks.
I.2.11 [ARTIFICIAL INTELLIGENCE]: Distributed Artificial Intelligence – intelligent agent, multiagent systems.
J.1 [ADMINISTRATIVE DATA PROCESSING]: – business, government, law.
K.4.3 [COMPUTERS AND SOCIETY]: Organizational Impacts – automation, computer-supported collaborative work.

General Terms
Management, Economics, Experimentation, Human Factors, Legal Aspects.

Keywords
Multi-Agent systems, Ontologies, Distributed Architecture, Social Services, Social Passports, Smart Cards.

1. INTRODUCTION

The Samara region is one of the largest and most well developed regions in Russia, a well-known centre of airspace industry. More than 3 million people live in the Samara region, 50% of them use various types of free social support including war veterans, elderly and disabled people, young single mothers, veterans of local wars, etc. The current legislative system which regulates various types and volumes of subsidies, benefits and rewards for different categories of citizens, includes more than 2000 federal, regional and municipal laws. Many of these laws accepted during the last 50 years contradict each other.

This is a serious problem for social services of each region which give support to their citizens. Firstly, social officers must be well aware of all these laws to be able to explain clearly to citizens their rights. Secondly, social officers must have an integrated picture for each person (address, career status, health condition, availability of rewards and medals, etc). This knowledge is important to avoid situations when increase of one benefit leads to decrease of all other benefits and to more efficient use of government budget. Thirdly, to get social support, it is necessary to fill in a lot of application forms which are confusing sometimes and social officers have always control and check if they are filled in correctly.

As a result, there is a lack of experienced specialists, social officers spend too much time on answering questions, citizens spend too much time queuing and are unhappy with bureaucracy and are under constant stress.

To solve all these important problems, we have developed a multi-agent system based on social passports and smart cards. Citizens can access the system via the Internet, Internet-kiosks which last version includes services of a cash-machine. In chapters 2, 3 and 4 of this article we will describe the developed
an approach to task solving and general system architecture, chapters 5, 6 and 7 will highlight some aspects of technical system architecture, implementation results and next steps of the system development. The key focus of this article will be description of agents and ontologies of the social sphere and advantages which these new technologies bring into the developed system allowing solving the above mentioned problems.

2. ONTOLOGIES, SOCIAL PASSPORTS
AND SMART CARDS OF CITIZEN

Today a citizen of Samara Region has the right to obtain a social smart card free of charge. It is called “smart” because it contains a microchip, and it looks just like a usual credit card. This card enables and simplifies procedures of obtaining free social services by a citizen, including non-cash transfer of social security money to his or her account and its later use to pay for housing, merchandise or to receive discounts in certain trading networks, etc.

However in order to use these services a person has to file different personal data, stored in data bases of different Ministries and Agencies. The smart card becomes the key to access those data bases. Part of the provided data is obligatory and needs to be confirmed with originals of certain documents (e.g., passport number, etc.). The rest of the data is optional and it enables the person to receive different offers from both governmental and commercial organizations. Obviously it is very unlikely that all these data will be accumulated in one data base. Instead at this stage we use ontologies to integrate information about a person. Our ontology of social sphere, defined in the form of semantic networks, acts as a metadata and contains data about location of different information on a certain person and its format. This allows using various data of different organizations “as is” and not bring them together and standardize, as well as to easily expand the system when new data bases of other Ministries are connected. As is known, the main problem in these situations is that information in the data bases may often be duplicated or conflict with each other, which requires corrections online. E.g., in some data bases street names begin with a lowercase letter, while in others – with a capital letter, although the actual address is the same. The correct records need to be chosen. Moreover, we use ontologies not only to extract records from data bases, but also to transform them into a instantiated semantic network in computer memory, i.e. to build a semantic network of copies of personal information. E.g., a person (object) may have (relation) “categories”, “benefits”, etc. Every “category” may “consist” of “social status” and other personal attributes. It all makes the created structure of personal data easily extensible, which is especially important in social sphere and in projects that are constantly expanding with new possibilities and require new information about a person. It is worthy of note that allocation of these data is voluntary and is needed only if a person wishes to receive monetary and other benefits from the government. Thus if, it is, e.g., necessary to connect an array of medical data to the social passport, it is enough to enter relevant notions and relations into ontology and describe access to correct fields in the medical data base.

Semantic network of personal information, generated while reading information from different data bases, is created only for a short period of communication session with a person and becomes source information for work of software agents of the system.

3. MULTI-AGENT SYSTEM OF SOCIAL SERVICES

The idea to create different constantly extensible software agents that were very compelling for implementation of modern e-Government concepts. The agents uninterruptedly work for the good of a man, ensuring his or her social support, taking care of his or her health and education, work and security, culture and sports.

As a basis of our approach we used the concept of network of supply and demand matchings, which is used currently in logistics, data mining, text understanding and other areas [1]. In this work we were focused on social services, but the developed approach may be easily expanded into other spheres.

Let’s look at key functions of the developed agents and types of their interaction:

Agent of a person – acts for and on behalf of a person, including search for offers in social support, health and other services that might be of interest to this particular person. An internet portal, where any organization can be registered with description of its capabilities and requirements, is used for that. However, the main feature of a person’s agent which partly replaces a social officer, is to recommend relevant social laws. E.g., the fact that a person has certificates of honour at work, which confirm successful labour over many years, grants him or her free tram tickets, etc. Such a recommendation can only be given on the basis of a thorough comparison of person’s social passport data with information in a social law, which is also represented in the developed system in the form of ontologies. As a result, an agent can advise on possible actions as well as on a list of documents necessary to obtain a certain benefit and even make an appointment with a district social officer. Besides, the person’s agent prioritises offers from governmental or commercial organizations to that person.

Agent of a social law – acts for and on behalf of a social officer, who initiates notification of relevant citizens that a law is applicable (in Russia in order to get you need to apply) according to restrictions of the budget and other priorities. It is especially of interest for new legislation which comes out of the Parliament without timely financing. In this case the agent of a law scans citizens’ social passports and finds out those, for whom application of these laws is relevant. At the same time appearance of a new law applicable for a person is an important event that initiates the agent of a person, which in its turn defines, what a person needs to do to obtain a new benefit.

Agent of a social officer – acts for and on behalf of a social officer. Its main task is to find citizens who require social support most of all. This task is also solved through analysis of social passports and social laws. Besides, this agent helps planning visitors’ appointments and may prepare appropriate laws for each visitor, as well as inform relevant citizens. E.g., a social officer may organize a special event and invite elder couples who celebrate golden wedding anniversary, or advise people who are soon to retire to acquaint themselves with social laws. Thus the
officer’s work with citizens in his or her territory is considerably simplified and intensified.

**Agent of a social organization** – acts for and on behalf of an organization officer. In the first place we are speaking of organizations that provide social services in terms of benefits defined by social laws, e.g., prosthetics for certain categories of citizens free of charge. Each organization providing such services may register on the above-mentioned portal and describe its capabilities and requirements with the help of extensible ontologies. On this event a person’s agent can analyze offers based on the social passport of a person, which contains a map of his preferences, and select offers that are valuable for him or her. If a person gives the permission, then in its turn, the organization may be notified that someone is interested in its services and may contact that person directly.

Availability of the agents already at the first stage of the system development allows achieving the following advantages:

- social organizations are more open to the public;
- use of the social legislation knowledge base by citizens and officers is simplified;
- interaction with a person is smart (targeted) and takes into account that person’s situation;
- notification of citizens about new laws that influence their social status is immediate;
- complexity of the system is increased successively without its radical redesign, by introducing new agent classes or expanding their functions;
- ease and efficiency of work with information is enhanced.

However the main advantage of the system turned out to be the fact that it is really capable of giving in-depth and accurate answers to urgent questions of citizens. We have observed several cases when social officers gave wrong interpretations of laws, whereas the system gave a more accurate and correct answer.

4. **REAL TIME KNOWLEDGE BASE**

In their work system users and software agents may use ontology-oriented knowledge bases. Unlike declarative presentation of the ontology, the knowledge base contains procedural knowledge (which uses ontology concepts and represents in fact important points of decision making) in the form of “If- Then” rule. The main knowledge base of the system is the base of social legislation of three main levels in Russia: federal, regional, municipal.

The OWL language is used as a basis for description of the knowledge base [2]. It was chosen as a result of analysis of modern methods of ontology representation as the mostly widespread, well specified and open for extension. Figure 1 shows a simplified ontological model for representation of laws in social sphere.

Basic concepts of description of a social sphere law are also present in this ontology: “categories of benefit recipients”, “benefits” and “documents”; their relations and classifications groups are defined. A separate rule is created for each document group and, in particular, for each specific document. It describes logic conditions and relations between the concepts, defined in real documents.

Use of ontology allows to indefinitely expand description of laws. Indeed, every new law very often adds new notions to the ontology. At the same time it is not required to rewrite program code if the system and even make changes in previous ontology descriptions. The OWL standard defines the format of ontology representation in the form of an XML file based on RDFS scheme [3], which allows use of ontologies in different software regardless of the platform. Internal way of storing and accessing ontologies in that software influences only their performance and reliability.

As an example let’s use regional law №122-GD “On governmental support of citizens with children”. It defines several benefits for families with 3 or more children, including “30% discount from statute-established public utilities fee”.

The following is a description of the benefit:

```xml
<owl:Class rdf:ID="30_percent_discount_for_public_utilities"/>
<owl:Restriction>
  <owl:hasValue rdf:resource="http://www.kg.ru/lawsBase.owl#Statute_122-GD"/>
  <owl:Restriction>
    <owl:hasValue rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
    <owl:Restriction>
      <owl:hasValue rdf:resource="http://www.kg.ru/lawsBase.owl#Public_utilities"/>
    </owl:Restriction>
  </owl:Restriction>
</owl:Restriction>
```

![Figure 1. Schematic model of representation of a social law](image-url)
This example illustrates the use of ontology language in description of social laws. It is worthy of note that description possibilities may be widened due to use of mechanisms of inheritance, import and definition of equivalency of different components. With the developed description and standard OWL ontology analysis tools it is possible to make conclusions on possibility of granting benefits to particular people. It was also essential to implement tools to access personal data in external information systems in order for the system to function.

In conclusion we’d like to mention that such descriptions on the internal level may be used by agents, but are also accessible to the public for navigation and browsing in a friendly visual interface of an internet kiosk (Fig. 2,3).

When new social law comes out, a social officer, certified by developers as an ontologist, has a possibility to add reviewed rules to the system without changing its code.

5. TECHNICAL ARCHITECTURE

The developed system historically was formed on the basis of quite a number of existing data bases of Ministry of Social and Humanitarian Development of the Samara region. The software was developed on three-level architecture with the use of J2EE technologies which allow creating platform-independent applications, including:

- subsystem of personal interaction with citizens with the use of internet kiosks;
- subsystem of decision making support for social sphere ministries, namely Ministry of Social Protection, Public Health, Culture and Education;
- Internet portal for integration of social sphere resources, which are organizations, authorized by the above-mentioned ministries.

Originally the system was hosted on one central server of the Ministry, which was accessed both from the local network by the visitors of the Ministry and its social officers and from the internet by the public. All data bases were also located on one server, which contained information on approximately 1.5 mln. people (Fig. 4).

However with the development of the system, namely with expanding it onto new Ministries and Agencies as well as introduction of the system to rural districts of the Samara region, a new goal was set: to create a distributed P2P system architecture with decentralized information storage, localized municipal services and capabilities of transparent user access to all nodes of
the system from any geographic location. At the same time the current central server located in Samara becomes only a “covering” pivotal unit in the regional network (Fig. 5).

As a result the system is organized as Service-Oriented Architecture which has nested nodes, but all of them, being autonomous parts of the system in the whole, may communicate with each other as equal. In future supposedly we’ll have even more geographically remote servers. Such cardinal transition to the distributed system urges to ensure openness of the system for integration of new servers, services and data on the move without system shutdown. It eliminates centralized management with its bottlenecks, typical for systems of such scale. Here every server of the system functions autonomously and uses constantly supplemented services, provided by other servers.

The most important step to construction of the distributed network was creation of a single repository of all ontologies, which is replicated and updated on all servers and ensures common knowledge for each remote server. It was made intentionally by analogy with a living cell, since different cells of an organism (heart, liver, etc.) curiously enough contain DNA data for the whole organism, i.e. ontology of the system in the whole.

Data access services operating on the basis of ontologies provide software agents with necessary information, which they receive from different sources, both local and remote.

6. KEY STAGES OF PROJECT
Development of the present system began in 2001 when the Ministry of Social Protection began the project of “inter-Ministry” common information space, integrating different data bases [4].

At this stage Institute for the Control Problems of Complex Systems and SEC "Knowledge Genesis", Ltd. by request of the Ministry of Social Protection and in close cooperation with it developed a concept of multi-agent system and social passport of a citizen of the Samara region. First pilot prototype of the system, which demonstrated possibilities of use of agents and ontologies, was successfully implemented. Basic tool that was used was Multi-Agent Engine (RC Version) and Ontology Management Toolset by Magenta Technology company [5], which allowed application programmers to implement specialized social ontology constructor and multi-agent system of important personal data representation in a short period of time. For the first time the Ministry of Social Protection was worried not about its own data bases, but addressed citizens and made its fundamental laws applicable to the situation of each particular person. As a result of these pioneering developments the regional parliament approved governmental IT development program in 2003. For the first time words “multi-agent system” and “ontology” were used.

With the pilot system built at the first stage the Samara Region Administration became the winner of “Electronic Russia”, a national-wide projects contest, held by the Ministry of Economics of Russia, leader of Russian reforms. The second stage of the developments began in 2003 – 2005. During this stage SEC “Knowledge Genesis” developed its own specialized software tools that allowed to quickly implement the basic functionality of the system on a large scale [6].

At present time the third stage of the system creation is being completed, replication and implementation of the system are being carried out. At this time the system operates in 27 municipalities of the Samara region and is available both via the Internet and 205 internet kiosks. Inhabitants of the region received 122500 social passport cards. In the course of this work we trained 150 social officers and certified 52 persons as ontologists with the right to expand the system with new social laws. The map of system implementation is shown in Fig. 7.

Today the knowledge base of the Samara region social sphere includes 168 statutes of federal, regional and municipal levels that define more than 350 types of benefits for 120 different social categories of citizens.

In the end, implementation of the system allowed:

- Increasing transparency of interaction with the authorities;
- Reducing the cues and simplify bureaucratic procedures;
- Providing citizens with targeted information on social benefits at federal, regional and municipal levels in real-time mode;
- Ensuring an effective implementation of social services;
- Simplifying delivery of services to citizens;
• Eliminating layers of government management;
• Making it possible for citizens, businesses, other levels of government and federal employees to easily find information and get service from the federal government;
• Simplifying agencies’ business processes and reducing costs through integrating and eliminating redundant systems;
• Streamlining government operations to guarantee rapid response to citizen needs.

On average, the time required by citizens to obtain information on benefits and payments available to them reduced from 10 days to 5 minutes, to execute notices for social benefits – from 1 month to 3 days, to receive payments – from 10 to 2 days.

At the same time the main users of the system are elderly people, who live both in cities and rural areas (Fig. 8), to whom the system turned out to be most relevant and valuable.

7. NEXT STEPS
These are the next main steps for the system development in new domains of the social sphere:
• System development in new social spheres: healthcare, civil registry office, public utilities, education, culture, etc.;
• Integration of social passport with medical insurance certificate, patronymic certificate (receiving money when a baby is born), pension certificate, etc;
• Transfer of social payments and a possibility to use these money in supermarkets, for paying flat bills and other expenses;
• development of a system for beneficial supply of citizens with medicine, etc;

It is also planned to develop a toolkit, architecture and functionality of the system:
• Transfer to a fully distributed SOA system architecture with P2P interaction of servers of various regions and institutions;
• Electronic protocol of interactions between ministries, organizations and citizens;
• extension of agents functionality which will be able to work pro-actively to implement a wider range of citizens’ demands and needs;
• creation of multi-user, distributed ontologies and solving problems of their collaborative building and using;
• support of social networks of citizens of the Samara region to implement principles of multicultural democracy.

As a more advanced and universal tool for building multi-user distributed multi-agent system, a new generation of Magenta Technology tools is now being considered. These tools include MyAgent Framework and provide new capabilities for text understanding, data clustering and agents learning based on experience.

We hope that with the further development of the system, citizens of the Samara region will be able not only to get any important document via Internet with the help of social passport without leaving their flat or office but also fulfill their social, political and economic interests to their own benefit and to the benefit of the whole Samara region.

8. RELATED WORKS
Development of the e-Government kind of systems is quite popular in the world at the moment [7][8][9] but governments of many countries are still not quite sure if they should integrate all confidential information about a person on one resource (social card), whether this has more disadvantages and is more dangerous when getting a social service. For example, these discussions are popular in Great Britain nowadays [10].
In Russia at the moment a lot of systems are being developed aimed to automate management process in regions (Moscow, Saint-Petersburg, republics of Karelia and Chuvashiya, Kursk, Arkhangelsk and other regions of Russia). Unfortunately, most of regional projects in our country and abroad deal with automation of business process between ministries and do not imply active and open dialogue between authorities and each citizen of the region.

The system under consideration brings brand new features and is focused to interaction with a person. The system implements the principal: not a person for the state, but the state for a person [7]. This is very unusual and new for our country which has a long history of suffering from totalitarianism. This principle can be fully implemented only on the basis of multi-agent approach and ontologies which makes these components crucial for successful system development now and in the future [11].

At the moment we do not know analogues to the developed system, or at least in materials for AAMAS 2006 we have not found any relevant reference.

At the end of 2005 the developed system was awarded with the golden medal at the World Exhibition of Innovation, Research and New Technologies “Eureka” in Brussels and the Governor of the Samara region got a golden medal for innovation success.

9. REFERENCES


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