We are developing bio-inspired multi-agent technology and systems for allocation, scheduling and optimization of resources in real time, as well as for solving other types of very complex problems. Our methods and tools allow to improve the efficiency of resource utilization and quality of client service, reduce costs and risks, minimize human errors in decision making.
1. INTRODUCTION
In the future new stage of information technologies development associates with Multi-Agent Technology which moves in step by step way to the level of critical nano- and biotechnologies (www.agentlink.org).
The reason of this quick growth coming from the opportunity to create new generation of computer systems based on bio-inspired principles of self-organization and evolution working for any kind of living systems, for example, such as ant colony or bee swarm.

2. MULTI-AGENT SYSTEMS
Multi-agent system consists of autonomous agents (software objects) able to react on events and analyze situation, make decisions and communicate with other agents.
Comparing with object-oriented approach the agent can’t be invoked as a state-less object and implemented as a method; but can be asked to implement the task – for this reason he need to talk with other agents and re-commitments; and this process can results in chains of re-commitments for finding new near to optimum solution of complex problem.
The decision of any complex task in this system is made evolutionary by interaction of dozen and hundreds thousands of agents which compete and cooperate with each other, create and break solution until the required quality level of problem solution is reached.
It allows to solve complex problems in a real time which cannot be solved by other ways, for example in the area of resource planning and optimization, data mining, patterns recognition, text understanding and others.

3. HISTORY OF DEVELOPMENTS
To develop this approach in transport logistics Magenta Technology company was established in 2000 in England (http://www.magenta-technology.com) on the basis of Russian Software Engineering Company “Knowledge Genesis” Ltd. This company developed innovative multi-agent technology for solving problems of discrete optimization for mobile resources.
Co-founders of this company are two European investment funds.
As a result in a short period of time there was created the first generation of dynamic mobile resources schedulers for solving problems of complex transport networks in real time in different transport logistics domains.

4. DIFFERENTIATION
The differentiation of this technology is that for each transport company’s order or resource it’s own agent that represents its goals, preferences and constraints. Agents continuously negotiate on Virtual Market trying to make best possible match. Difiers from traditional, centralized, hierarchical, sequential, batch scheduling systems the developed multi-agent systems for resource planning and optimization represent the community of agents-optimizers with their own schedules, which work in quasi-parallel bio-inspired way identifying conflicts and negotiating trade-offs in real time. As a result agents are able to respond to any events very quickly and flexible by solving conflicts and rebuilding links in scene, which represents real world situation, from dozen and hundred thousand connected operations. Agents react to events coming in real time or able to improve results proactively if there’s enough time.
Advantages of such approach are ability to solve complex problems of resource management in real time, and also openness, flexibility and efficiency, productivity and reliability of created systems.
But the most important feature of designed resource planning and optimization technology is adaptability to form and execute plans. In our approach plan is not formed from the beginning every time when new event comes as it’s done in usual batch optimization methods but plan is just continuously updated and executed on a rolling basis by events in real time.
Developed systems can be easily integrated with GPS/GLONASS systems, RFID equipments and mobile devices, electronic maps, Internet-services such as on-line weather forecast or traffic jam receiving, etc.

5. INDUSTRIAL APPLICATIONS
Developed multi-agent schedulers are used in for running the largest big size tanker’s fleet, the largest fleet of corporate taxi in England, one of the most large truck’s fleet in Europe and others.
As a result the efficiency of resource utilization and service level for clients were increased, costs and risks were reduced; as well as dependence of human factor.
For example developed multi-agent system of resource planning and optimization for corporate taxi company allows automatically plan 13 thousand orders on 800 cars, equipped with GPS – navigation equipment, by keeping touch with drivers through mobile phones within a day. As a result within a month after implementation amount of fulfilled orders was increased by 7% with the same fleet of cars, right now 97% of all taxi orders are planned automatically, without dispatchers taking part in it; amount of orders fulfilled not in time is 3.5 times less (2%); taxi idle run was reduced by 22.5%, right now each taxi fulfills 2 more trips during the week with the same costs on time and fuel, that lead to gain profitability from each car by 5%; time spent on taxi ordering is less on 40%; time for training of new operators is 4 times less; web-site works more efficiently now and can process already about 16% of orders.

6. NEW GENERATION OF MULTI-AGENT SYSTEMS
In 2009 “Knowledge Genesis” Ltd. was transformed into Group of Companies with the goal to design and implement new generation of more innovative and powerful multi-agent platforms and products.
Now one of companies specifically dedicated to development of intelligent real time scheduling solutions is “Smart Solutions”, Ltd (www-smartsolutions-123.ru/en).
The new generation of our systems is designed to support the whole cycle of intelligent resource management: response to events, adaptive resource planning in real time, interacting with all participants for coordination of actions through mobile phones, monitoring of plans fulfillment and finally jobs re-planning in case of growing gap between plan and reality.
The key features of new generation of multi-agent systems: 1) shift to p2p networks of multi-agent systems; 2) bottom-Up approach for building Ontology for domain knowledge capturing; 3) learning through experience.
Such approach will allow company to solve more complex problems of dynamic resources allocation, scheduling and optimization.
At the time we are mainly working in areas:
- Smart Aerospace
- Smart Transportation
- Smart Factories
- Smart Field Services
- Smart Railways
- Smart Supply Chains
This list includes systems working for clients.

1. **Smart Aerospace**

   Smart Airports

   Together with Ministry of economics of Germany, University of Cologne, Airbus and some other partners the project is completed on designing multi-agent RFID based simulator for on-ground airport services management.

   In this project all services are organized as a swarms of agents adaptively changing plans to unpredictable events and coordinate plans.

   Projects for International Space Station

   The first project is made for the biggest world-scale Rocket & Space Corporation “Energy” (Russia) and is aimed at cargo transportation for International space station (ISS). User can build flights program, enter new launches of a spaceship, change type of spaceships and start-up time and enter other events that can change possible ways for cargo delivery. But cosmonauts and systems of ISS have their needs like need for water and air, fuel and food, equipment repair, etc. As a result of system operation cargo deliveries can be dynamically rescheduled, for example, amount of fuel and water, products for cosmonauts’ live support and some other resources can reallocated between flights of spaceships. At the moment this solution is in every day operations. Currently a number of new projects is under development in the areas of rescue operations management, scheduling of shifts of dispatchers, project management, etc.

   Swarm of Satellites

   In this project company provides the platform for modeling “collective intelligence” with cooperative behavior in the group of orbital space satellites for remote Earth sensing. If new job is coming or one satellite looses object or discovers its new features, that should be investigated in more detail, then satellites cooperate and decide how to change plans.

2. **Smart Transportation**

   Smart Trucks is the multi-agent management system for long-distance freight transport It is developed and implemented for several big logistic companies in Russia. Among them are “Prologics” (Moscow), “Lorry” (Ekaterenburg), “Monopoly” (St-Peterburg), etc. The system increases the resources efficiency and speed up the process of decision making, provide transparency of business—critical processes in the company. Now we are developing SaaS version of the system and new system for consolidation of orders for city deliveries.

3. **Smart Factories**

   Multi-agent system is made for workshop resource scheduling and optimization in real time including workers, equipment, materials and other. This system was created for a large-scale airspace enterprise but can be applied for any factories, that require individual approach to each article production, have small production batches, require high workers qualification, have to deal with multiple unexpected events and require high efficiency and flexibility in product manufacturing.

   The system is implemented at “Axion-Holding - Izhevsk Motor Plant” saving about $100k a year just in one workshop and some other factories. Currently the system is on delivery stage to “Aviaagregat” and “Kuznetsov” factories for assembling shassi and aircraft jets.

   Now Smart Solutions won a contract with Ministry of Education and Science of the Russian Federation to develop a distributed intelligent system for manufacturing workshops. In this projects we work as a technology leader and coordinator in the consortium of companies, including “Oboronprom” and Samara State Airspace University.

   In consortium with EADS and Airbus, as well as the Universities of Cologne, Manchester and Prague and some other partners we have won a IP project for the European ICT program «Factory of Future» to design a new generation of intelligent manufacturing systems which are able to interact and learn from experience.

4. **Smart Field Services**

   The objective of the solution is to improve the service level and reduce delays in emergency claims execution, increase resource utilization for all mobile teams and field services, for example, for regional gas distributor. Smart Solutions has developed the solution which effectively distributes the claims between the mobile teams, makes scheduling and re-scheduling in case of unpredictable events, monitors and controls execution of plans and communicate with drivers via mobile phones. In the process of adaptive re-scheduling the solution takes in consideration priority of claim, position and work load of teams, business process, routes and distances, etc. Adaptive scheduler analyzes about a hundred options per second and chooses the most effective one, which can also be interactively adjusted by dispatchers and communicate with teams by mobile phones.

   The solution is fully integrated with GPS-sensors, e-maps, in-house ERP system, economy-class mobile phones.

   Multi-agent system is delivered for 004 Call Center for regional gas distribution network. The results of the solution is a 40% increase in mobile resource efficiency.

5. **Smart Railways**

   The concept of network-centric multi-agent platform for designing distributed p2p networks of intelligent systems for passenger and freight transport for "Russian Railways" is developed. At the moment the first system for high-speed trains is delivered which helps to adapt schedules of Sapsan trains on Moscow – Saint Peterburg railway network in case of unpredictable events. The system for cargo trains scheduling is under developments.

6. **Smart Supply Chain**

   First version of multi-agent system for real time scheduling of more than 600 kinds of goods to 20 shops in Chicago area was created for Lego company (USA). The system has proved significant increase in profitability by shifting managers to real time decision making.

   Smart Solutions signed a contract with Barlowsot (UK), the largest provider of supply chain simulators, for designing multi-agent resources scheduling module.

7. **CERTIFICATES AND AWARDS**

   Company is accredited in Russian Ministry of Science as innovative SME, certified in software developments for Russian Federal Aerospace Agency, has ISO 9001 certificate.

   New generation of Smart Solutions products for Intelligent Transportation, Factories and Mobile Field Services are awarded as a “Best products” on National Exhibition “Soft-Tool 2011”, Chamber of Commerce of Samara Region awarded company as a “Best Company 2011” and “Innovative Company 2012”.

   A daughter company was established in Skolkovo (Russian “Silicon Valley”) and got grant for new developments at the end of 2011.

   Now a new daughter companies are established in Moscow and Saint Petersburg, London, Jacksonville and Cologne.

   The project for Lorry transportation company won a prize of “Best IT Project 2012” by Russian National Association of IT directors.

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   Knowledge Genesis Group:

   http://www.knowledgegenesis.co.uk/
Attachments: Federal Aerospace Agency and ISO 9001 Certificates

National Russian Awards for Best products Soft-tool 2011

Samara Region Award for Best Company 2011 and Innovative company 2012