

Intermediary Service Provider for Supply Chain Management

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Abstract— The paper introduces a solution for supply chain management based on simulation of enterprises interaction in integrated information space. A multi-agent solution of Intermediary Service Provider is proposed to provide orders flows forecasting based on interval correlation analysis. Implementation of presented solution was performed by SEC Open Code as a part of simulation decision-making support center.

I. INTRODUCTION

Basic challenges of modern supply chain management are concerned with a necessity to support cooperation between a number of independent enterprises with various goals and constraints. Negotiation of these enterprises is characterized by an autonomous behavior that can result both either in active and effective cooperation or in counterproductive conflicts. Taking into account a positive effect from competition all the supply chain members should move to common goals, which is hard to follow in case of high autonomy of decision makers.

This problem becomes even harder in case of negotiation of enterprises in virtual mode in integrated information space. Modern software provides a high level of autonomy and adaptability, which is positive in terms of competition, but makes it complicated to manage multiple companies as the members of solid supply chains. In case any enterprise can enter or leave the market and considerably change the situation, it becomes impossible to build any strategically consistent plans and capture all the business contract agreements and business commitments into a solid schedule.

To solve this problem, we propose a new concept of scheduling based on representation of enterprises as autonomous actors and their functions as services instead of rigid business processes. This concept is close to service industries like tourism or transportation. In this paper there is proposed an Intermediary Service Provide (ISP) solution for multiple enterprises – members of supply chain that is capable of taking and providing for them a number of services targeting effective cooperation on the market.

II. STATE OF THE ART

The concept of ISP [1] is based on modern principles of distributed simulation and decision-making support powered by multi-agent technology [2]. The virtual world of

negotiating service providers and customers should be treated as a complex network of continuously running and co-evolving intelligent agents. Such solutions are based on Holon's paradigm and bio-inspired approach [3, 4], which requires development of new methods and tools for supporting fundamental mechanisms of self-organization and evolution similar to living organisms.

Intelligent agents have been usually opposed to traditional optimization [5], still the areas of their application should be considered different. For ISP provider there can be proposed some practicable and advantageous combination of network-based optimization and multi-agent decision-making support as described below.

The idea of ISP was motivated by recent developments in transportation industry [6]. This proposed approach is close to 5PL (Fifth Party Logistics) concept, which is based on implementation of a number of services for customers and enterprises provided by a specially designed software platform. 5PL platform is open for new transportation companies and even drivers and helps them negotiate with customers in integrated information space.

As for the enterprises represented by actors or agents, intermediary services should consider a combination of human and time factors [7]. Interaction of customers and service providers powered by intermediary services generate and can be characterized by a big number of events that form Big Data and require modern technologies for its analysis [8].

Business processes that support such interaction should be flexible and dependent on unique customer requirements. This makes it reasonable to implement subject-oriented approach for business processes management (S-BPM), which conceives a process as a collaboration of multiple subjects organized via structured communication [9].

On the basis of the mentioned approaches there is proposed a model for interaction of customers and service providers as subjects in integrated information space of ISP implemented using multi-agent software.

III. CONCEPTUAL MODEL

We consider the virtual space where enterprises can intercommunicate issue a sequence of requests for related

managed by direct instructions. From the other side, in case the ISP platform provides durable solutions the users will trust it and wait for a certain period of time giving the system an opportunity to generate and compare separate options and analyze the influence over the whole network.

ISP solution is presented at Fig. 2. It introduces optimization functionality: the system starts helping its users to find the best combination of services according to their requirements.

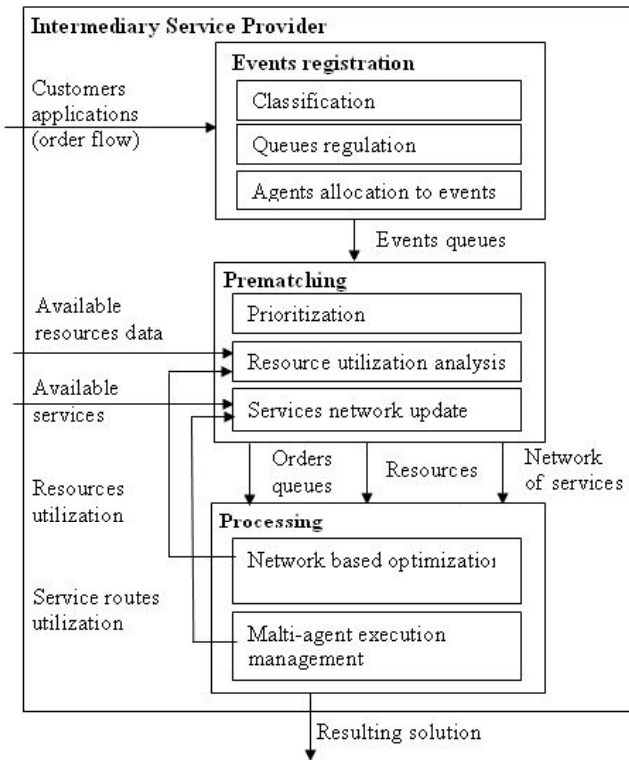


Fig. 2. Intermediary service provider concept

The logic of such an optimization is described by the following algorithm:

1) For each demand d_i there is generated a number of chains of options $v_{i,j,l,k}$ for related services requested by $q_{i,j}$. These chains form the set of service route variants $\mu_m(d_i) = \{v_{i,j,l,k} = 1\}$, $m = 1..M$, where M is the number of service route option.

2) Starting from the first required service the system makes the forward pass considering the sequence (precedence) relations between the options to determine minimum $T_m(d_i)$. Loading of g_k is considered at this stage to determine the earliest possible start and delivery of the service provided.

3) The set of route options $\mu_m(d_i)$ is prioritized by $T_m(d_i)$. This implicitly satisfies the goal (5) as soon as the fastest service requires taking preferably free resources.

4) On the way back the system accumulates $C_m(d_i)$ cutting the options with increasing costs (which corresponds to branch and bound principle). In case of equal service costs there will be chosen a provider with lower involvement into other service routes.

5) The route option with minimum cost is the result.

Optimization logic is extended by multi-agent functionality. Agents are introduced to represent the customers and service providers in the integrated information space and can be triggered both for simulation of customers activity and for representing the real customers in the process of searching for the integrated services. The architecture of multi-agent scene is quite simple: there are introduced three types of agents for Customers, Service providers and Services. Customers and Service providers can interact according to their objectives and constraints and establish the links of cooperation according to which the Services are transmitted.

The strategies of agents correspond to the goals (3 – 5). The Customer agent tries to reduce the time and costs of the integrated service, and the Service Provider agent tries to increase its utilization delivering as many services as possible. The process of search can be presented as a sequence of local contracts between the customers and service providers. It is proposed to make this process free, flexible and be based on the principles of self-organization.

In the context of the supposed solution connection between project management, supply chain and actors' interaction will be presented in a certain way.

At the first stage, the enterprise management makes decision in implementation of a certain project. Then, it makes a decision about the decomposition of the project in a number of tasks. The project implementation (elaboration of each task) is followed by the set of project life cycle events, and the efficiency of all projects' implementation depends on effective activity. It is worth mentioning that for large enterprises, project life cycle events form the big data. Therefore, the processes of the overall performance analysis of the enterprise and the processes of finding the closest optimal decision are more complicated at each stage.

The accounting of interaction key performance indicators and a complex index (superposition of indexes given above) in the given time points will allow to carry out monitoring and adjustment of the management process. The analysis of indexes is carried out in the unit of analytics. The decision-making process takes place in the control unit that is generally consists of several layers characterizing certain types of management influences.

The balance of the key criteria that is used in management layers is developed (modifications of the organization structure, actions directed on formation of motivation, strategic and operational jobs re-planning and information control of interaction staff management). It is a result of combination of analysis of correlation indexes, project and organizational activities.

Let's imagine a supply chain of particular enterprise as a layer between a project planning and a virtual space where take place interaction between actors (enterprises). It is presented in Fig. 3. Index m marked for actors means main enterprise with project plan is belonged to. Last block in a scheme is virtual space where each enterprise can offer a number of their services to others and take an offer to use other enterprises' services. Direct arrow means that main enterprise use services of 1, 2, 3 and 4 enterprises and render its services to an enterprise number 5.

There is a supply chain that represented as a sequence of rendered services. This sequence is flexible. It means that considered supply chain has no strict timing. Events can happen simultaneously, they are not depending from each other and this is the main difference from usual business process management. Each actor brings in the supply chain its service that it offers to the main actor. Every part of the supply chain is needed for some task. Connection between all parts of the scheme is carried out in this way.

V. ANALYSIS FUNCTIONALITY SUPPORT

Organizational project management system represents set of the subdivisions and positions or enterprises combined by a supply chain that are connected by relations and subordinations. In the case of management structure creation, it is necessary to consider specifics of enterprises' activities and features of their interactions with an external environment.

The process the organization structure formation of project management usually includes three main stages: determination the type of the organization structure (direct subordination, functional, matrix, etc.); separation of structural subdivisions (administrative staff, independent subdivisions, applications programs, etc.); delegating/devolution of the authority and responsibility for parts of the project to the subordinate authority levels (governance relation – subordination, the centralization relation – decentralization, organizational mechanisms of coordination and monitoring, a regulation of subdivisions' activities, development of regulations in structural subdivisions and positions).

This architecture affects the organization structure of enterprises' functioning, project part, management system, units of the analysis and analytics, product life cycle events, the functional relations.

Resource assignment is provided according to the performed project specification (tasks) in the form of the oriented organization – activity network. The nodes represent the staff of the enterprise (performers and their principals), and the links – the relations between the employees. Based on the proposed solution there can be introduced the following process of project management using Big Data analysis for knowledge engineering.

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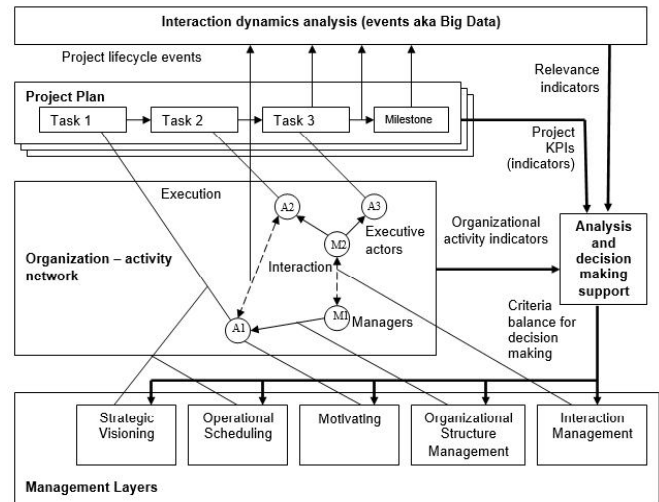


Fig. 3. Coordination of plans based on Big Data analysis

Therefore, the processes of the overall performance analysis of the enterprise and the processes of finding the closest optimal decision are more complicated at each stage.

From this point of view there can be studied three major types of planning horizons that can help managers achieve their organization's goals: strategic, tactical, and operational. Operational plans lead to the achievement of tactical plans, which in turn lead to the attainment of strategic plans. In addition to these three types of plans, managers should also develop a contingency plan in case their original plans fail. The specific results expected from departments, work groups, and individuals are the operational goals and refer to operational plans. These goals are precise and measurable. An operational plan is one that a manager uses to accomplish his or her job responsibilities. Supervisors, team leaders, and facilitators develop operational plans to support tactical plans.

A tactical plan is concerned with what the lower level units within each division must do, how they must do it, and who is in charge at each level. Tactics are the means needed to activate a strategy and make it work. Tactical plans are concerned with shorter time frames and narrower scopes than are strategic plans. These plans usually span one year or less because they are considered short-term goals.

Long-term goals, on the other hand, can take several years or more to accomplish. Normally, it is the middle manager's responsibility to take the broad strategic plan and identify specific tactical actions.

A strategic plan is an outline of steps designed with the goals of the entire organization as a whole in mind, rather than with the goals of specific divisions or departments. Strategic planning begins with an organization's mission. Strategic plans look ahead over the next two, three, five, or even more years to move the organization from where it currently is to where it

wants to be. Top-level management develops the directional objectives for the entire organization, while lower levels of management develop compatible objectives and plans to achieve them. Top management's strategic plan for the entire organization becomes the framework and sets dimensions for the lower level planning.

Contingency planning involves identifying alternative courses of action that can be implemented if and when the original plan proves inadequate because of changing circumstances. Events beyond a manager's control may cause even the most carefully prepared alternative future scenarios to go awry.

Unexpected problems and events frequently occur. When they do, managers may need to change their plans. Anticipating change during the planning process is best in case things don't go as expected. Management can then develop alternatives to the existing plan and ready them for use when and if circumstances make these alternatives appropriate.

VI. IMPLEMENTATION

The represented solution was implemented by SEC "Open Code". The company offered to use sizable multi-touch surface to provide information about major enterprises of Russian Federation. One of devices' modes is presented at Fig. 4. A multi-touch surface is a touch screen. By allowing multiple touches, gestures can be performed on surface. These gestures are typically simple things like pinching and pulling on an image or map to zoom in and out.

The device develops technology to work across all the major platforms. It works natively on a range of Windows, Mac OS X and Linux operating systems. Users can easily share content from laptops, tablets, or phones. With inkback and touchback, all changes will appear on compatible personal devices. Sizable multi-touch surface should be hanged on the naked wall at the convenient level to provide access to the whole surface of device.



Fig. 4. Sizable multi-touch surface

Interactive actors map is displayed on the screen of the device (Fig. 5). The device has a few modes. In general mode it displays a map of Russia with streets, buildings and names of the main natural objects (rivers, mountains). The map can

be displayed on the several modes such as Earth, Map (original landscape), Traffic and Terrain. Scale of the map can be zoomed in to the each street. Interactive objects on map is enterprises only. Also, it can show current situation on roads (mode Traffic). The device provides search functions.

A list of all available enterprises can be sorted by chosen characteristics.

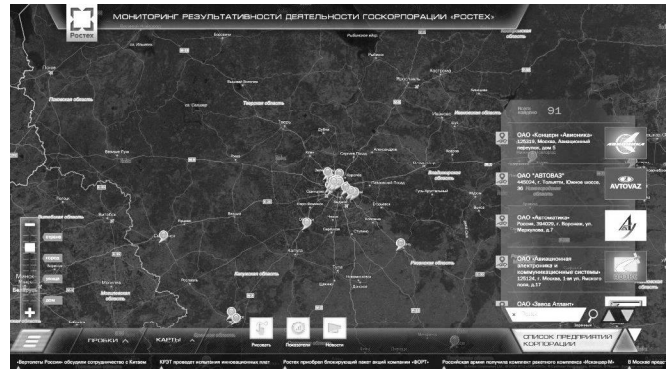


Fig. 5. Interactive actors map

This map shows current state of each enterprise and relations between enterprises. Information about major enterprises are already loaded and kept up to date. Users can add related and new data to the system and correct false or outdated information.

Each enterprise has its own record, which contain all information about it such as contacts, web site, key performance indicators, etc. (see Fig. 6). Each record card can be represented in the different forms. In the form of short or full information about enterprises' history. In the form of statistics presentation as a bar chart, a pie chart and a pyramid diagram. Also, there is a form of enterprises web site and recent news. Furthermore, there is a search form, by witch means user can find targeted information about the particular enterprise throughout.

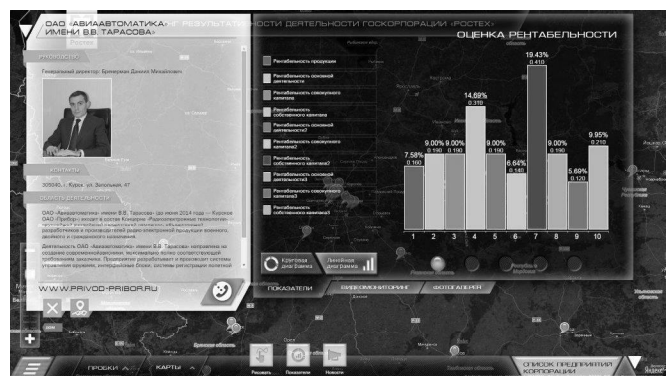


Fig. 6. Statistics of the enterprise

Moreover, there is a direct Skype call function (see Fig. 7) to a representative office or Head of the enterprise. All Skype contacts are already downloaded on the data base of the device. Connection is provided by camera placed on the top of the device. This function can be really useful for holding a meetings or to direct negotiations.

Furthermore, there is an online-translation function. By means of this function users can get information about work process in different departments, workshops and sections of the particular enterprise. It might be a powerful tool for making effective presentations as a part of annual report or a new product presentation. This function helps users to graphically demonstrate the way that enterprise producing goods and product.



Fig. 7. Call to head of the enterprise

On the basis of the proposed approach there was developed a system of decision-making support based on the data of digital archives with the use of knowledge bases technologies will make for achieving the following challenges:

- to provide the storage of the archive information electronically;
- to provide independence of places for storing the documents from work places;
- to make the provision of information continual regardless of the location of work place and the schedule of archive work;
- to make the processing of inquiries and the provision of archive data quicker;
- the integration into a unified information infrastructure;
- to make the provision of the response and the making of decisions complex situations quicker;
- to improve the quality of the management decisions which are made.

Intelligent analysis and the annotation of scanned documents allows to transform the information to knowledge by adding semantic descriptors. The transformation of documents to knowledge is made automatically using the artificial intelligence system principles based on the use of knowledge – ontologies, that considerably reduce the need to attract the expert regarding knowledge. Navigation and search are made based on the semantics of the documents, that allows to not just increase the relevance of the results, but also to introduce the user into the documents, of the existence of which they were never aware, but which would be relevant for them.

The semantic web permits to describe extremely complicated and diversified connections between the

documents. An opportunity to set random attributes of a document allows to describe it more precisely that will certainly improve the quality of search. In the mode of interactive dialogue with a user, there is an opportunity to do not just keyword search, but also reach the documents that are somehow related to the found ones.

VII. CONCLUSION

In this paper, we propose to perform a supply chain as a virtual non-structured business-process. This thesis leads to creation of a new type of intelligent intermediary service provider (ISP). Nowadays interaction between different companies and enterprises has no universal basis. It has a lot of disadvantages such as long time wasted for correct coordination, lack of any cross functional platform for interaction. That is why it is so important to create a universal virtual platform where enterprises can intercommunicate and exchange services and goods.

A supply chain is the network of all the individuals, organizations, resources, activities and technology involved in the creation and sale of a product, from the delivery of source materials from the supplier to the manufacturer, through to its eventual delivery to the end user. ISP solution allows to make interaction between different companies more effective.

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