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METHOD OF THE CONFIGURATION ANALYSIS FOR DESIGNING INDUSTRIAL INFORMATION SYSTEMS

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Introduction. There is considered the problem of alternative projects set formation at elaboration of industrial information systems (IS). There is given analysis of traditional approaches to the solution of the problem and a new method is suggested. In the base of the method lies the configuration analysis technique reflecting features and possibilities of the engineering design.

1. Question state. Alternative projects generation problems are considered in the "Decision making theory" ("Independent choice problem", "Complete set problem" [1, p.164]), in the theory of Automatic Systems Control (ASC) ("ASC tasks structure choice problem" [2, p.161], "ASC hardware structure choice problem" [3, p.25], in project analysis "Designing problem", "Construction problem" [4, p.96]). The above problems are related to the class of "alternatives initial set (AIS) formation problem" [1, p.159].

In the process of AIS formation problem there are used conditions of "possibility" and "accessibility" alternatives which are defined by concrete characteristics of a complecting component as well as technical requirements and restrictions of the customer. According to this ASC formation is realized in two stages: on the first one – the generation of possible alternatives is made and on the second – testing for permissibility. In separate cases the stages can be combined.

AIS formation problem statement depends of the problem specificity. In particular the alternatives can be considered as integral objects (for instance, typical configurations of information systems) or as the objects having structure (for instance, original configurations of information systems projected under concrete order). In the theory the general and partial statements of AIS formation problems are usually reduced to integer-valued problem of linear programming [5, p.67]. However in practice general algorithms of solutions are not always effective because of large dimensions and different restrictions and special algorithms taking into account the problem specificity are worked out.

2. Peculiarities of IS AIS formation problem. Technical-economical peculiarities of industrial information systems ASC generation problem are such that the sense of the question is changed radically. In the forefront there are put:

(1) nonformalised character of the problem excluding the possibility of traditional statements using and formalized solution methods;

(2) the problem accents displacement from the domain of AIS generation procedure mathematical formalization to the practical, engineering domain.

In this connection become critical the questions of a) working out alternative construction regular procedure reflecting the peculiarities of chosen IS architecture line and its apparatus program realization, b) revealing and verifying technical restrictions system determining the generated alternatives "possibility" condition, c) defining and checking alternatives economical characteristics determining their "permissibility" condition.

The enumerated peculiarities of the problem require working out non formalized, engineering methods of IS AIS generation.

3. The Method of solution. In the paper an original method of IS AIS generation is introduced. Method is based on elements of the configuration analysis [6, p.63-81; 7, p.36].

The method takes into account the circumstance that today when architecture models, computer platforms, hardware and software are brought to the level of industrial standards or at least to the level de-facto, the project alternative generation can be conducted already in the form of project technologies (D) [4, p.47].

In configuration analysis D technology realizes the mapping $D : K \xrightarrow{(K_3)} A$, where

K is structured knowledge of the problem area;

K_3 – structured knowledge of the solved task area;

A – initial set of alternative of IS configurations;

K includes:

(1) K_α – set of D-configurators (project sample) of IS architectures; (example of K_α for IS with client-server architecture is given in fig.1);

(2) K_τ – set of D-configurators (project sample) of software, hardware built by recursive way in architecture configurator;

(3) R – rules of K_α and K_τ integration and mounting of A on their basis according to the Project Technical requirements;

(4) N – normative–reference base including system catalogue of accessible components and acting standards.

K_3 includes:

(1) KB'3 – coding sheet forming Technical requirements (organization-technological structure of the enterprise, functional structure of the designed IS and etc.);
(2) F* – list of IS consuming properties established by the customer;
(3) Q* – integral indexes of the projects efficiency (functions, cost, payment flexibility, installation simplicity, scalability, accompanying simplicity, noise-immunity, reliability etc.);
(4) $\Omega(L^*,C^*)$ – satisfaction principle establishing the conditions of possibility (L*) and permissibility (C*) of the alternatives.

Initial set of alternatives A include:

(1) S – structural scheme of hardware, software and information architecture of the chosen architecture;
(2) $\Omega^\circ(L^\circ \subseteq L^*, C^\circ \subseteq C^*)$ – the indicator of the alternative possibility (from the point of interface and physical restrictions realization) and permissibility (from the point of cost restrictions realization);
(3) F* – the alternatives consuming properties estimation criteria;
(4) Q° – integral index of the alternative efficiency.

For every architectural type of IS there is worked out its own D procedure (configurator and integration rules), for example for "mainframe/terminal", "client/server with bus topology", "client/server with star topology", "client/server with ring topology", "client/server with mixed topology" etc.

Such representation gives set of possible alternatives generation syntactic models.

For the alternatives permissibility check-up there is used the procedure of "structured restrictions" expertise (or identification regular procedure) which takes into account interface and physical (memory capacity, number of the attached devices, possible distances and transmission speed etc.) characteristics of the components $\{K_i\}, i=1,..,n$. As the result there is distinguished subset of sets – variants of components $<K_j, d_1, ..., K_{ji} d_i>$ which are not admissible in common. The configuration analysis algorithm is like that.

4. Engineering realization. IS projects developers are designers whose thinking and language are oriented not on mathematical statements and their solution methods and on the information represented in the data form and the knowledge reflecting the objects and relationships in the field of information science. So there is need in clear language of configuration design whose words are objects names, their properties and relations – just those words of natural language which are used by the computer techniques suppliers, designers and users in their daily activity.

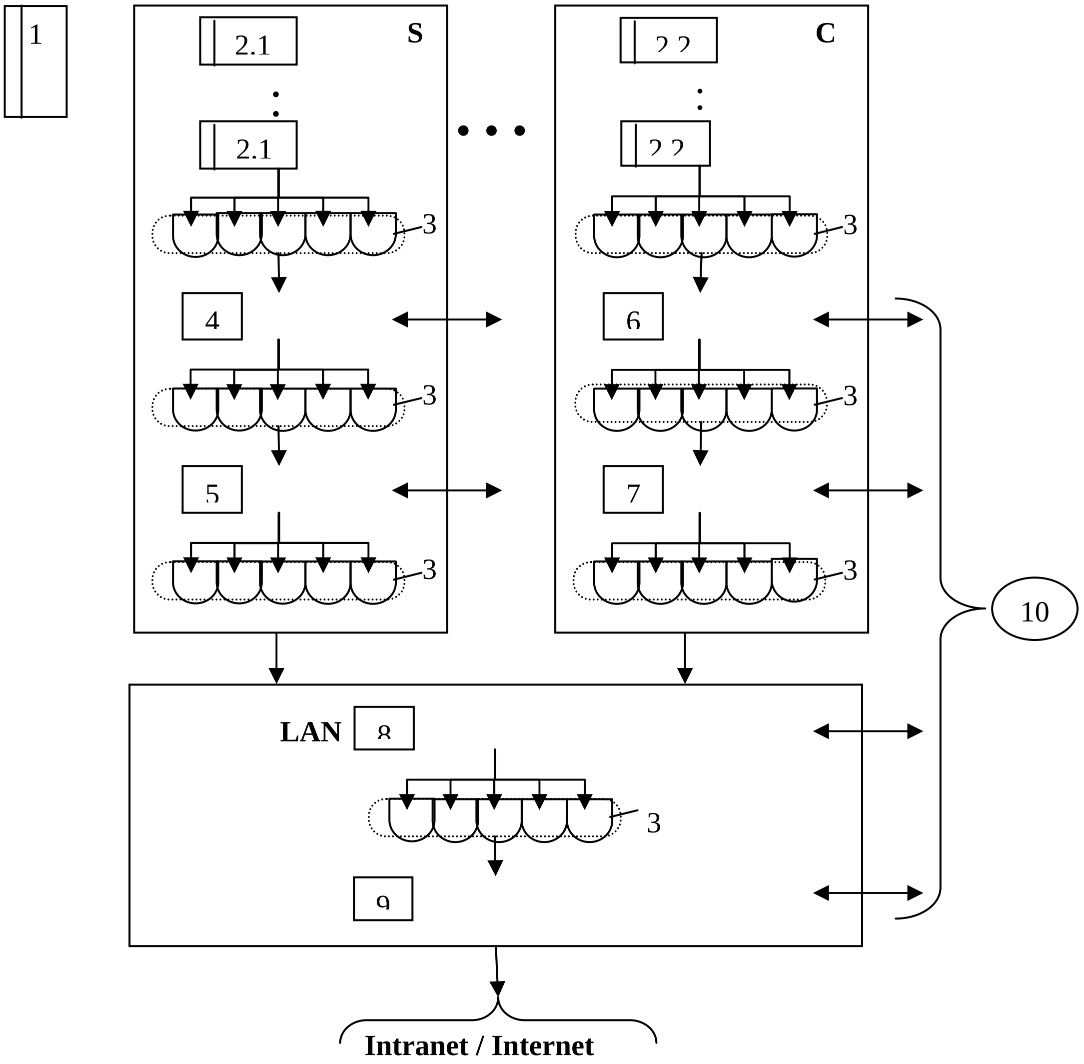

Fig.1. Structural scheme of D-configuration of Information system with architecture client/server [8].

Notation conventions:
S, C, LAN – zones of the server, clients and local network equipment installation respectively
1 – IS functional sub systems;
2.1; 2.2 – problems solved on the server and clients correspondingly;
3 – system requirements to software and hardware of the server, clients and local network;
4 – software configuration (general-system and applied programs and development software) of the server;
5 – the server's hardware configuration;
6 – he client's software configuration (general-system and applied programs and development software);
7 – the client's software configuration;
8 – LAN hardware configuration;
9 – LAN software configuration (network OS, protocol stack, network drivers);
10 – IS consumer properties tree;
↔ – associative links "IS communication facilities-properties": "arrow to the left" points to the communication facilities which realize the corresponding IS property; "arrow to the right" points to the property realization degree by the given communication facilities.

According to this the engineering language of configuration analysis has been worked out. In this language the principle scheme of D-configurator is given by the $K_D =< L, R, N >$, where L are language means for the problem statement description and structure synthesis results representation; R is operational rout of structure synthesis performed in the form of technological instruction (manual or automatic); N is normative–reference base of the configurator including systematic catalogue of the acting normative documents and permissible complete set components.

The worked out design language is adapted for IS configuration engineering synthesis by three main schemes: 1) original design on the base of components; 2) design on the base of typical project or project-analogues; 3) assembly design on the base of typical project solutions.

Method of configuration analysis was used at elaboration of:

1) IS project for Working Group of Azerbaijan Department of UNDP (UN Development Program). The project general contractor is American Universal Activity Consulting company;
2) typical IS project for automation of power supply enterprise statistic and bookkeeping accounts collection and introduction processes;
3) local network project for AO "Azenergy" .

5. Conclusion. The experience of the method application in this and other projects showed that on the initial stages of design (Technical requirements, Technical task) the method gives an opportunity to solve two important practical problems:

1) to norm the consuming properties of the projected IS with account of the enterprise specificity;

2) to form IS project configuration supplying the required properties of IS in optimal way, i.e. with minimal expenses and observation of many non formalized restrictions, conditioned by interface and physical peculiarities of integration (memory capacity, operating speed, modification step, range and etc.).

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