The Concept of Coordination Strategies Models in Hierarchical Systems

Mounir Gabsi[1]

[1]Mounir Gabsi, information technology, *Higher Institute* of *Technological Studies* (ISET), Nabeul, Tunisia
mounirgabsi@yahoo.fr

Abstract : *Abstract-----Use of decomposition-based design optimization methods requires a priori selection of system partitioning and of the corresponding coordination strategy. Typically, partitioning systems into smaller, easier to solve subproblems leads to more complicated, computationally expensive coordination strategies. Previous optimal partitioning techniques have not addressed the coordination issue explicitly. Decomposition-based design optimization methods can ease difficulties associated with complex system design. Their application, however, requires that both a system partition and a coordination strategy are defined a priori. The partitioning task involves clustering m analysis functions required for the system design problem into N subproblems. Subproblem solution must be coordinated in a way that leads to a consistent and optimal system design. Partitioning and coordination decisions should be made such that the decomposed problem is less complex to solve than the original undecomposed problem*.

Keywords: **Management, Models, strategies, Coordination, dynamic systems.**

1. Introduction

The development of modern industrial conglomerate structure, which includes information management, manufacturing, transportation, power-components, creates a situation that cannot be solved alone at the top level of the hierarchy. The reason for this phenomenon are:
• mismatch strategies to achieve the objectives.
• vagueness of the goals and global goals-orientation;
• misinformation attack information from different sources;
• attacks on production and management structures;
• inconsistency level managerial and executive staff in decision-making;
• Information disorientation personnel between levels of the hierarchy because of the low level of knowledge;
• lack of respect between staff of different levels of management hierarchy;
• technological disruptions in the production process due to the low level of problem-oriented knowledge of operational staff ACS-TP;
• conflicts between multi-levels hierarchies staff through improper allocation of financial resources.

2. Synthesis Models of the coordination strategies in the hierarchical systems

The appearance of the hierarchic structure control is caused by an increase in the complexity of the objects technologies, controlled which, in turn, generates difficulties for centralized control [1,2]. The decomposition of entire process of decision making to this quantity of levels, which would allow it represents the solutions of the optimization problem of control for each of them, is under such conditions one of the basic approaches to the presence of the solution[3]. As is known, as a result of the appearance of the horizontal and vertical distribution of functions complex system can be examined in the form the collection of the managers of centers. Each such center is characterized goal-directed by behavior, which is determined by existence of its own resources. As a result this together with the appearance of the multilevel hierarchical systems for control appeared the new task of agreement and coordination of the solutions at all levels of control adopted [4,5,6]. Decomposition-based design optimization methods can ease difficulties associated with complex system design. Their application, however, requires that both a system partition and a coordination strategy are defined a priori. The partitioning task involves clustering m analysis functions required for the system design problem into N sub problems. Sub problem solution must be coordinated in a way that leads to a consistent and optimal system design. Partitioning and coordination decisions should be made such that the decomposed problem is less complex to solve than the original unrecompensed problem. Engineering insight traditionally is used to partition a system, and system designers can select a coordination strategy based on their experience or follow qualitative selection guidelines available in the literature. Formal approaches can lead to improved partitioning and coordination decisions [7]. An increase in effectiveness and flexibility of coordination mechanism with making of the operational, tactical and strategic decisions is one of the ways of the optimization of the work of data of systems during increase in the dynamics of the influence of external and internal medium and complication of its structure [8,9,10]. Usually the task of coordination it is proposed to examine in the wide and narrow senses. The task of coordination in the broad sense - this is the modification of the structure of control system, i.e., the selection "optimum diagram of interrelation" between the centers of decision making, on which is propagated coordination signal . The task of coordination in the narrow sense - is a selection "optimum coordination signal", which with the propagation along the hierarchical system (within the framework a constant structure) makes possible to direct and to synchronize the activity of the centers of decision making for achievement of the global purpose of the functioning of system .

Within any organisation, the departments, sections and individuals must all be organised in such a way so as to ensure that the overall strategic objectives of the organisation are attained and that each department, section and individual makes a contribution. It is essential that the efforts of each contributor are coordinated to ensure that objectives are met. The function of an organisation i.e. attaining a strategic

objective, is operated via the attainment of contributory objectives by departments, sections and individuals. This is why efforts at all levels must be coordinated. As the business plan will cover all departments of the organisation, so all of the departmental plans and budgets must be coordinated, so that they are all working together to achieve the business plan. For example, sales should be planning to sell the number of units which the production departments agreed to produce otherwise there will be either unsold stock or unfulfilled orders. Functional plans cannot proceed without regard for those of other functions. There must be coordination between them and an integration of all towards successful performance.

3. Decomposition of the hierarchical system structure.

Strategy Coordination includes the following procedures:
• establishing operating rules for each level of the hierarchy;
• selection of actuators for each type of transaction;
• calculation of information-resource interactions between elements and structures at all levels of the hierarchy;
• Develop standard solutions for each type (class) strategies to achieve global goals.

Let us examine the process of the structural decomposition of hierarchical system.

To do this, select the $<P_i, i = 1,n>$ local processes for each i-th level. Thus we $<V_m^i>$ input streams and outputs a set: $<U_{mk}^i>$ - resource, $<U_{ml}^i>$- Information Governing parameters $<< y_{if}, y_{iw}>$. Then the concept of synthesis is based on the theory of goal-oriented control systems of industrial structure. This utility function is given in the form of functional quality. This determines the optimization tasks of the maximization of the functional of quality on the basis of the procedure of the decomposition of hierarchical system to two components by the purpose of entire system:
• the hierarchy of structure;
• the hierarchy of the solutions to control.

The need of determining the function of usefulness appears in cases when the not clearly assigned purposes of strategic control, which, in turn, requires the decomposition of task to two blocks (Fig. 1).
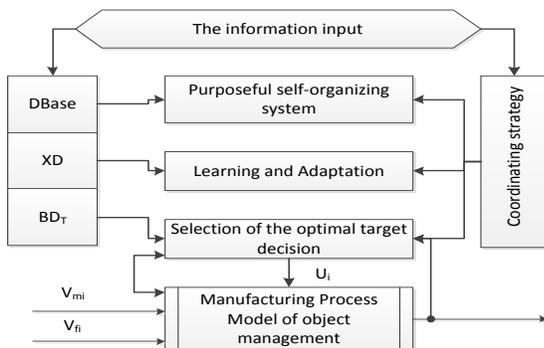

Fig. 1. Decomposition of the structure of production system to the administrative and technological components

Interaction between the levels specified as a system of equations:

$$\begin{cases} U_{if} = K_{if}(y_{if}...y_{nf}); \\ U_{iw} = K_{iw}(y_{iw}...y_{nw}), \end{cases} i \in [1,k];$$

Coordination executed by control elements which take local decisions based on minimization of the functional quality [14].

$$G_{i\beta}(m_i) = \sum_{j=1}^{k} \beta_{fi} y_{if} + \sum_{j=1}^{k} \beta_{wj} y_{jw};$$

For the connected administrations they must respectively the expression:

$$U_{if} = \sum_{i=1}^{m} y_{if}, U_{jw} = \sum_{i=1}^{m} y_{iw}, \forall j \in [1,s].$$

On the basis of the equations of the balance of resources it is built the controlling influences:

$$\sum_{i=1}^{m} \hat{y}_{if} = \hat{U}_{jw}, \sum_{i=1}^{m} \hat{y}_{iw} = \hat{U}_{iw}$$

Consider the basic concept of synthesis management strategies [81, 84].

• **The concept of the coordination Of Mesarovich:** realizes by the system of control through the production of matched interaction between the levels-th hierarchy according to the evaluations of input signals and synthesis controlling influence for the correction of the state of objects on the basis of the global function of the quality:

$$G(m) = G(m,P(m)) = \min_{M} G(m)$$

Accordingly

$$\begin{cases} G: M \times Y \to V; M = <M_{i,i=1,n}> \\ H: M \times Y \to U; H^*: M(\xi,t) \to U^* \\ P_i: M_i \times U_i \to Y_i \end{cases}$$

where U - control with the uncertainty of state, M – set of alternative actions, Y – set of results,
Pi - original function, G - the function of estimation, the V - the characteristic parameter of quality, U * - is disoriented administration.

Accordingly for each coordinating signal β must be satisfied the condition:

$$\forall q_{i\beta} \in G: [\min_{M_i \times U_i} g_i(\beta,m_i,u_i) = \min_{M} g_i(\beta,m_i,K_i(m))]$$

when $U_i = K_i(M)$

For such a strategy the coordination is conducted for the optimization of the function of quality . Very behavior of system in the explicit form is not mapped into the state space and purposes.

• **Concept of the coordination of Aliev.** On this concept on the basis of the decomposition of the task of control after strategies of coordination is achieved the construction the integrated automated control systems, which have hierarchical multilevel structure. Here strategies of coordination, based on the procedures of the agreement of the

system of local purposes at all levels of structure, protrude as the means of achieving global goal.

Coordination control for the concept of the coordination of Aliev is formed in the form system the criterion also of limitations, in this case the attacks lead to the disinformation:

$$\exists Strat(U \mid C_g): \Phi_i(x_i) = (\varphi_{i1}(x_1)...\varphi_{ik_i}(x_i)) \to \max_{T_i};$$

$$H_0(F_1...F_N) \to \max_{T_i};$$

$$H(F_1...F_N) \to b \in B;$$

$$F_i \in S_i^F \stackrel{\Delta}{=} \{(x_i \in P_i^x) \vee (x_i \in R_i^x)\}, S_i^F \subset Q_i^F \subset Y_i^F$$

$$y_i^e(t+T_{mi}) = f_i(y_i^e(t), x_i^e(t+T_{mi}), t \in T_k$$

where P_i^x - Pareto set, x - vector of a set of alternatives, H_0, ..., H - system limitations, F_0 - objective function, R_i^x - set semi effective points in the space variables, F_i - the function of the levels of the hierarchy.

The structure of information, which is transferred from the elements of the level of hierarchy to to center it is described through the versions of the criteria of state in the form:

$$\exists Strat(U \mid I_k, T_m):$$

$$\Phi(x) = (<c,x>,...,<c_k,x_k>) \to \max_{T_m} I_k;$$

$$\forall x \in X: x = (x/A_x < b, x \geq 0);$$

$$F(x) - (<d_i,x>...<d_m,x>).$$

where $\Phi(x)$ - the vector of criteria, d_i, c_i - coordinates of the permissible state, which can be eroded due to the attacks and in this case misinform the system of decision making.
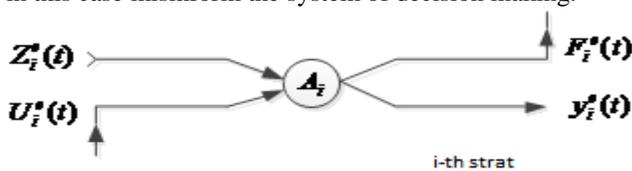

Fig. 1.2. Structure of the detection of the attacks

• **Procedure of coordination in the dynamic systems with the distributed structure** . Let the system consist of the N- subsystems, each of which is described by differential equation in the state space in the form:

$$y_i(t) = A_i \cdot y_i(t) + B_i \cdot U_i(t) + C_i \cdot Z_i(t);$$

$$y_i(t_0) = y_0 \to 0;$$

$$Z_i = \sum_{i=1}^{N} T_{ij} \cdot y_i, i \in [1, N];$$

where U_i - vector of administrations, y_i - vector of outputs, $(Z_{\xi i}, Z_i)$ - the vector of entrances, A, B, C - matrix, $Z_{\varepsilon i}$ - misinforming signal.

Global objective function is assigned in the form the combination of the local:

$$I = \sum_{i=1}^{N} I_i;$$

$$I_1 = \frac{1}{2} y_i(T) Q_i \cdot y_i(T);$$

$$I_2 = \int_0^T \frac{1}{2} [y_i(T,t) P_i \cdot y_i(t)] dt$$

$$I_3 = \int_0^T \frac{1}{2} [U_i(T,t) R_i \cdot U_i(t)] dt$$

$$I_4 = \int_0^T \frac{1}{2} [Z_i(T,t) S_i \cdot Z_i(t)] dt$$

$$\exists Strat(K_U \mid G_{C_i}): [I(T) = opt_{T_m} \sum_{i=1}^{n} I_i];$$

where Q, P_i, R_i, S_i - positive definite matrix.

The optimization of strategy of coordination is built on the basis of the gradient search:

$$\max_{u \in U} I(strat U \mid G_C) = \min_x \Phi(\lambda);$$

$$\Phi(\lambda) = \max_{y,u,\lambda} (L(y,u,\lambda);$$

accordingly the coefficients of Lagrange (x_i, $i = 1, N$)

$$L(y,u,\lambda) = \sum_{i=1}^{N} (I_1 + \int_0^T \lambda_i^T (Z_i(t) - \sum_{i=1}^{N} T_{ij} y_i(t)))$$

In the case of acting of the disturbing factors and illegible data of equation they will be stochastic and therefore the procedures of optimization will be nonlinear on the basis of use statistician and fuzzy logic.

• **Shapiro's concept.** The synthesis of strategies of coordination is achieved by situation to estimations accordingly obtained given from the levels and by the alternative choice regions, in which the effectiveness of the behavior of system will be optimum:

$$\pi_V : \mu(R) = \mu[\Pi S_\pi(y_1...y_n)];$$

$$y: \{\mu_f(x,y) > \lambda, y \in Y\}; \mu: [x \times x] \to [0,1];$$

$$x: \{\mu_f(x,y), y \in Y\};$$

Where ΠS_π - the illegible surface of belonging in the state space, μ - function of belonging, R_i - set of rational decisions.

For the dynamic system of the form:

$$x_{i+1} = \Gamma(x_i, u_i), i = 0,1,2...T-1, \mu_i(u) \in F(u)$$

fixed control $(u_0, u_1,...,u_{i-u}) \in U, x_0 \in X$ and are calculated the parameters $x_T = x_T(x_0, u_0, u_1,...,u_{n-1})$. As a result the function of belonging with global purpose $\mu(u_0, u_1,...,u_{T-1})$ takes the form:

$$\mu_Q(x_{T-n}) = \max((\mu_{T-n}(U_{T-n}) \wedge \mu_R(x_{T-n+1}, Q_{T-n+1}))$$

$$x_{T-n+1} = \Gamma(x_{T-n}, U_{T-n}), n = 1,2,...T.$$

Search strategies based on integrated blur game:

$$\Gamma_{Lf} = \{\Gamma_{if}[X, \overline{U}, \overline{V}, \overline{Y}], L_i, Q_i\}, \overline{U} \subset optStrat_{T_m}(U,C);$$

where x_i - state space, Y - space of the estimated parameters, U_{Fo} - control on many strategies, V_{Fi} – set of maximum strategies, L – set of limitations, Q – set of criteria,

Γ_i – set of local games of view $\Gamma_{if} : [Y \times U \times V_i] \to Y$ of the set of belonging Y, $F(\ )$ – the membership functions.

В играх создаются коалиции действий $K_{di} \in K$, and the coalition of the interests $\{K_{ni}\} \in K_N$ on basis of which is determined strategy and region of the feasible solutions on the basis of the rule:

$$\mu_R = \{ \underset{i=1,N}{\wedge} \mu_{Q_i}(\lambda), \lambda \geq 0,5\} \Rightarrow \exists optStratU \ a$$

Graph model synthesis coordination strategies [5]. One of the key problems of formation and decision-making is to provide information support to assess the situation. Intelligent information systems using the knowledge thereof be strongly laid in them , help the coordinator (x0) to adjust the behavior of an industrial $(\vee K \equiv [x_1, x_2 ... x_6])$ on the basis of data processing for the current administration and for prognosis.
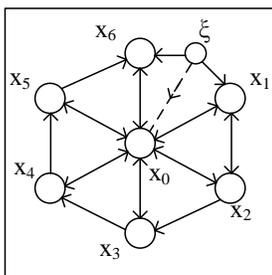
Information about the properties and requirements of objects $\vee K$ can be represented through linguistic or quantitative evaluation of the parameters of the target and the target in space systems.

$$< \min Rx_{ijk} \leq Px_{ijk} \leq \max Rx_{ijk} >; B = \| x_{ij} \|,$$

$$\xi \to <\vee K : [x_1 ... x_6]>, \hat{P}x_i = Px_i(t, \xi);$$

where R_{xj} – requirements set object , x_j, ξ – attack , P_{xj} – object properties x_j, K index criterion, (x_i, x_j) – indices of connected objects, В - structural matrix .
Consistency properties and requirements of related objects $(A_K \to B_K)$ as expressed by proximity :

$$S_K(R_{AK}, P_{BK}) = \mu_S(A_K, B_K);$$

$$\mu_S(A_K, B_K) = \begin{cases} 1, if \ R_{AK} \cap P_{BK} \neq 0; \\ 0, if \ R_{AK} \cap P_{BK} = 0; \end{cases}$$

$$\mu_S(A_K, B_K) = \frac{|R_{AK} \cap P_{BK}|}{|R_{AK} \cup P_{BK}|}; \mu_S \in [0,1].$$

where (A_K, B_K) - carriers of fuzzy sets parameters.
The degree of coordination requirements in coordination strategy defined through indicator measures include for each object $\vee K$ -structures .

$$I_K(P_{BK}, R_{AK}) = \min(P_{BK}, R_{AK}) / P_{BK};$$
$$I_K(R_{AK}, P_{BK}) = \min(P_{BK}, R_{AK}) / R_{AK}.$$

n order to reconcile the requirements and compromises y $\vee K$ in coordinated $<x_0 \leftrightarrow [x_1 ... x_k]>$ formed feature selection as additive models

$$F_V = \frac{1}{2}[\frac{1}{K_j} \sum_{K=1}^{K_j} S_K(R_{AK}, P_{BK}) + \frac{1}{K_Z} \sum_{K=1}^{K_Z} S_K(R_{BK}, P_{AK})]$$

with coefficients requirements (Ki, Kz).
Harmonization of requirements based on the principle of maximum effective compromise

$$G_K(d) = \max_{d \in D} \sum_{j=1}^{N} \sum_{i=1}^{N} Y_j \sum_{K=1}^{K_i} W_{jk} S_K(Rx_{jk}, Px_{ik}) \ \text{where}$$

Y_i, W_{jk} - weights structural organization of an industrial complex .
Strategic coordination control based on expert DSS [6,7]. The most effective strategy for coordinating management is based DSS that includes knowledge component and expert coordination of local strategies. Synthesis procedure includes:
   • Identify problems experts.
   • Goals-formation strategies . in solving problems within the mission system.
   • Selection criteria decision-making.
   • Development of a strategic action plan .
   • Analysis of possible scenarios of events and their prognosis.
   • Development of tactics and the executive and managing teams.
   • Correction and adaptation terminal cycle of strategic management in terms of information attacks.

3. CONCLUSIONS
The paper considers a model of synthesis strategies and analyzes approaches to solve the problem of coordinating management in hierarchical systems with distributed structure .In the paper we proposed models for coordination in hierarchical systems , these models are efficacies especially in developed countries, we showed the importance of information management systems allowing us to better manage all levels of the system by keeping the coordination between all the parameters.

.
REFERENCES
   i.   Eppen G. Centralized Ordering Policies in a Multi-Warehouse System with Lead times and Random Demand/ G. Eppen, L. Schrage// In: Multi-Level Production/Inventory Control Systems, Theory and Practice. – 1981. – P.51-58.
   ii.   Federgruen A. Centralized Planning Models for Multi-Echelon Inventory Systems under Uncertainty/ A. Federgruen// In: Handbooks in OR and MS. Graves, S.C. et al.: North Holland. – 1993. – P.133-173.
   iii.   Sikora L. Cognitive Models and logic operational management in hierarchical integrated systems at risk : [user] / LS Sikora .; Center strategic . Studies . Eco- Bio- Engineering. systems , National University " Lviv Polytechnic " , Ing. Acad. Ukraine . - L. : [EBTES] , 2009 - 432 pages.
   iv.   Cachon G.P. Supply Chain Inventory Management and the Value of Shared Information/ G. P. Cachon, M.Fisher// Management Science. - 2000. - No.46(8) . - P.1032- 1048.
   v.   Chen F. Information sharing and supply chain coordination/ F. Chen//Operational Research and Management

Science: Supply chain Management. – 2003. – P. 341-421.

vi.   Porteus E. L. Responsibility tokens in supply chain management/ E. L. Porteus// Manufacturing and Service Operations Management. – 2000. – Vol. 2. – No. 2. – P. 203-219.

vii.   A. Kusiak and J. Wang. Decomposition of the design process. Journal of Mechanical Design, Transactions of the ASME, 115(4):687–695, 1993.

viii.   Gupta D. Performance evaluation and stock allocation in capacitated serial supply systems/ D. Gupta, N. Selvaraju// Manufacturing and Service Operations Management. –

2006. – Vol. 8. – No. 2. – P. 169-191.

ix.   Khrushch N. Decision -making in the strategic management of enterprises / NA Khrushch , OS Korpan , MV Zhelihovska // Herald Khmelnitsky National University. - 2010. - № 1. - T.1. - P.41-45.

x.   Slowinski R. A generalized definition of rough approximations based on similarity/ R. Slowinski, D. Vanderpooten// IEEE Transactions on Knowledge and Data Engineering. – 2000. – Vol. 12. – No. 2. – P. 331-336.