Quality of digital information resources in condition of global info-telecommunication system multifaceted management

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Abstract This article is analyzing methodological aspects applied to information epoch environment, in particular, to economy. It is displaying expediency of using “information economy” term instead of technical concept “digital economy”. At that, a more profound concept “digital information resource” is used. It is demonstrated that classical services are now considered as an element of digital information resources. The paper is identifying, generalizing and shaping characteristics of global info-telecommunication system. It is clarifying the constructive definition of cyberspace concept. It is revealed and structured the difference of cause-and-effect relations between quality of means of production and quality of manufactured products and provided services applied to new object — cyberspace. It is displaying co-subordination of concept identified as “information security” in relation to concept identified as “information resources delimitation” of economic entities. On the basis of analysis and previous investigations, the problem and the hypothesis of new sphere of scientific research was revealed and shaped. Problem decomposition into the totality of first-priority scientific tasks was performed.

1. Introduction
Implementation of entire national and international programs of strategic development is predetermined by scope and quality of involved (used) digital information resources (DIR). As a matter of fact, this refers to new information epoch which comes into full display primarily in the sphere of economy. New economy is named “information” due to the fact that indicators of entire economic entities (competitive strength, productivity, income etc.) depend first of all upon their ability to generate process and effectively use information which is based on learned laws and regularities of nature and society [1]. Maximum items and services productivity level is achievable only under the condition of global info-telecommunication system. This is indispensable condition of information economy existence. Global info-telecommunication system (GITCS) is to a greater or lesser degree used by more than 4 billion people out of 6.8 billion population of the world. However, quality of digital information resources greatly depends on GITCS condition.

2. Methods
Authors used the following methods: system analysis, theory of operations, results of statistical theory of communication, theory of quality assurance, fundamentals of theory of communications, theory of information security.
Global info-telecommunication network is characterized by a number of new fundamental features:
— as for throughput capacity and probability of information misrepresentation, it is considerably exceeding the capabilities of natural environment, moreover, there is a definite trend of expanding this gap;
— GITCS has no general designer and no system of interdependent criteria (requirements) of other than one control system and no finite number of elements on which base they are arranged;
— process of GITCS creation and temporal development has beginning but has no end;
— GITCS is simultaneously providing services for great number of varying (by size and other indicators) control systems including those which are functioning with antagonistic purposes;
— changing of parameters (a part of which — on a real time basis (120–180 s and less)) is performed from numerous control centers (points) which are geographically dispersed, linked to different extent or even not linked or implemented with antagonistic purposes.

It should be underlined that apart from means and ways of well-directed control, GITCS is sufficiently influenced by indirect control, namely:
— unintentional and intentional change of (I) scope and character of information under processing and (II) structure of informational attraction between network subscribers;
— untargeted or pre-chamber changes of GITCS element characteristics (parameters) or distortion of monitoring subsystem results which is considerably changing possible sets of managerial solutions and procedure of implementation thereof;
— dynamic changes of access points of considerable amount of network subscribers even without change of generated or received digital information resources;
— permanent, hardly predictable aperiodic changes of political and military situation are causing probable information flow routing to change so as to secure or expand economic indicators of communication providers;
— permanently growing number of destructive impacts on the part of individual and organized cyber terrorists.

situation is becoming more complicated in view of the fact that GITCS, unlike classical systems of communication providing limited scope of services associated mainly with information resources transmission, is providing increasingly growing number of services requiring well-coordinated and multifunctional control.

Formulated arguments enable the authors to clarify structural definitions [2, 3, 4] of new object of investigation and cyberspace.

It is a global, scalable, inhomogeneous artificial environment [5] which has distributed, multifactor, split-level and multipurpose management system and provides conditions for digital information resources existence and presentation in the interests of internal and external users, including antagonistic ones, by control system functioning purposes.

Necessity of authors’ cyberspace concept clarification is pre-determined by the fact that, in general understanding, network-centric control assumes implementation of well-coordinated and non-contradicting goals while actual cyberspace control situation is absolutely different.

Classical cause-and-effect link between quality of production means and quality of provided products and services as applied to GITCS [6] and DIR does not allow ensuring the required level of adequacy. Graphical interpretation of interlink types in reference to dedicated networks functioning for the interests of control system authorities is shown in figure 1.
Figure 1. Graphical interpretation of standard cause-and-effect link for dedicated control systems.

Situation, if referred to cyberspace existence and functioning environment, is becoming more complicated [7, 8].

Characteristics and respective indicators of GITCS elements depend either upon its own characteristics or upon scope and properties of DIRs under processing [9, 10]. Graphical interpretation thereof is presented in figure 2.

Figure 2. Graphical interpretation of inverse correlations typical for cyberspace.

Emerging situation requires to timely undertaking advising and controlling activities because it is practically impossible to take these factors into account when such dissimilar and antagonistic systems are under service. Therefore, it will be necessary to continue development of a set of terms and definitions characteristic for information security theory. For the emerging situation it is very important to ensure delimitation of DIR belonging to different owners, while “security” term is more adequate for description of phenomena applied to dual situations, mainly to isolated systems providing functioning of particular control systems.

At that, it becomes possible (I) to evaluate economic and technical efficiency of security facilities and, as appropriate, (II) to perform DIR delimitation. Means (ways) of DIR delimitation should reduce (however, to smaller degree) information resources accessibility for legitimate users and ensure [as minimum] less level of accessibility for non-legitimate ones.

$$\exists_{s,p,d} = \frac{D_{lp}}{D_{nlp}}$$ (1)

At that, efficiency of delimitation means may be generally defined by expression:

Individual and generalized indicators of accessibility may be also used.

Investigations made it possible to identify quantitative link between digital information resources and conventional resources using which on systematic basis it is possible to create items and services possessing the use value [11, 12].

Results have been obtained with the use of analytic-simulating modeling methods. At that, the following first-priority problems have been formulated and solved:

— development of model with market entities possessing equivalent resources;
— development of model with market entities possessing dissimilar resources;
— development of methods of assessment of market entity characteristics usage for the purpose of commercially valuable resources obtaining.
In aggregate, formal assignment of task consists in defining the functional dependency of market monopolization probability upon the relations between conventional and information resources possessed by market players.

Disclosure of these regularities will make it possible to solve a number of first-priority and practically important problems:

With pre-determined material assets correlation — to define levels of awareness sufficient to achieve goal with desired degree of probability (direct problem);

With pre-determined levels of awareness — to define material assets correlation sufficient to achieve goal with desired degree of probability (reverse problem);

With pre-determined probability of global goal achievement — to form a set of pairs of conventional and information resources relations enabling the goal achievement.

It may further enable the researcher to evaluate economic efficiency of (I) information resources security and (II) retrieval of commercially valuable information about competitors and about upper tier environment.

Unlike initial information model of the market the authors clarified functioning algorithm and some other less valuable parameters.

Analysis of (I) modeling results, (II) economic theory provisions and (III) results of commercial relation practices shows that re-distribution of assets earlier owned by expelled marker entities among the remaining entities in proportion with their asset values fails to adequately reflect the real situation. In view of this, the procedure of expelled entities' assets re-distribution among those entities that are advancing in the direction of goal (i.e. as applied to I and IV quarters of market space in Euclidean metric) was fulfilled.

Input data for modeling are as follows:

— initial market potential — \( W_i \);
— quantity of market entities — \( N \);
— value of deterministic component of stochastic assets of non-informed market entities — \( l_i \);
— value of deterministic component of stochastic assets of informed market entities — \( l_j \);
— relative value of stochastic component of initial assets — \( \xi \);
— relative value of awareness of \( i \)- and \( j \)- market entities — \( \frac{l_i}{l_j} \);
— final share (percent) of market monopolization \( \mu^{\text{spec}}_p \);
— goal coordinates — \( X, Y \);
— specified accuracy of modeling — \( \varepsilon \);
— specified reliability of modeling — \( p \).

Calculation of experiments quantity at specified accuracy and reliability of modeling is performed by the formula:

\[
N = \frac{z_{\alpha/2}^2 \sigma^2}{\varepsilon^2}
\]  

(2)

Taking into account that process of market entity informing is multi-channel it is expected that respective sensors will generate random values subordinate to normal law of distribution.

\[
\bar{\xi} = \sqrt{\frac{12}{n} \sum_{i=1}^n r_i - \frac{n}{2}}
\]

(3)

\[
\bar{\xi} = \sum_{i=1}^{12} r_i - 6
\]

(4)

Any market entity or specified quantity thereof may be identified as more informed, however, in order to simplify program realization it is better to select initial elements of respective set [13, 14]
Theoretically, correlation limits of initial assets values and awareness may be different, however, experiments were fulfilled with account to practical situation [15].

3. Results and discussion

Generalized algorithm of market information model with consideration of described factors [16, 17] is presented in figure 3.

Figure 3. Generalized algorithm of market information model with market entities possessing different-tier resources.

Relative commercial value of information resources [18] is in inverse proportion to quantity of entities possessing identical information and is in direct proportion to financial and technological capacities of particular market entity possessing the identical information.

Quantitative information-conventional assets dependency assessment shows [19] that market entity possessing 30 times smaller assets but who is 3 times better informed will gain leadership within 44 trade cycles. If assets are 10 times less and awareness level is 3 times better it means that number of trade cycles to gain leadership is 4 times less.

Analysis of situation [20] makes it possible to formulate hypothesis of forthcoming scientific research of new phenomenon.

Essence of this hypothesis is as follows. Achieved GITCS functional level is generally ensured owing to (I) excess content and productivity of elements and (II) structural linkedness, however, it is limited by a set of poorly linked, retarding and multifaceted controlling actions.

Problem of DIR quality improvement consists in the lack of methods and ways of controlling the cyberspace which would essentially differ from controlling the antagonistic control systems in condition of destructive actions.
4. Conclusions
Within the framework of problem discussed it is possible to formulate a number of first priority tasks requiring solution:

1. Retrieving of homogeneous (as per individual and/or generalized criteria and fragments) GITCS for further investigation of their influence on DIR quality.
2. Retrieving of factors and sources of destructive controlling actions aiming to subsequent classification, localization and elimination thereof.
3. Structuring of the set of controlling actions aiming to improve quality of GITCS and, accordingly, DIR.
4. Provision of complex of techno-economic proposals aiming to fulfill the substantiated controlling actions.

References
[1] Castells M 1998 The Information Age: Economy, Society and Culture (Moscow: GU-VshE) 625
[2] Starodubtsev Yu I, Begaev A N and Davliatova M A 2017 Information services quality management (Saint Petersburg: Politechnic University Publ.) 67
[3] Davliatova M A, Khnykina T S and Starodubtsev G Yu 2017 Mezhdunarodnyy tehniko-ekonomicheskiy zhurnal 2 82–85
[4] Davliatova M A and Starodubtsev Y I 2017 Strategic Partnership of Universities and Enterprises of Hi-Tech Branches (Science. Education. Innovations) 215–217
[5] Brechko A A, Lvova N V, Starodubtsev Yu I, Vershennik A V, Buharin V V and Vershennik E V 2018 Method for modelling of elements deliberate damages of the communication network functioning for the benefit of diverse including antagonistic control systems, patent №2655466
[6] Brechko A A, Lvova N V, Starodubtsev Yu I, Vershennik A V and Vershennik E V 2018 Method for dynamic modelling of communication networks taking into account interdependence of their elements, patent №2665506
[7] Cybersecurity threatscape Q4, https://www.ptsecurity.com/upload/corporate/ru/ru/analytics/Cybersecurity-threatscape-2017-rus.pdf
[8] Fedotov A V 2010 Bases of a reliability theory and technical diagnostics: abstract of lectures (Omsk: Publ. OMGTU) 198
[9] Starodubtsev Yu I, Alisevich E A and Terentyev G A 2015 Problems of economics and management in trade and industry 10 124
[10] Alisevich E A, Starodubtsev Yu I and Samorukov V I 2015 Trends and management 3 252–262
[11] GOST R ISO 19011-2012, http://docs.cntd.ru/document/gost-r-iso-19011-2012
[12] GOST R ISO/IEC 17021-1-2017, http://docs.cntd.ru/document/1200146130
[13] GOST R ISO/IEC 1702117065-2012, http://docs.cntd.ru/document/1200102883
[14] GOST R ISO 9000-2015, http://docs.cntd.ru/document/1200124393
[15] GOST R ISO/IEC 17024-2011, http://docs.cntd.ru/document/1200089427
[16] Wagner G 1972 Fundamentals of operation investigations (Moscow: Mir) 336
[17] GOST P 55568–2013, http://docs.cntd.ru/document/1200103730
[18] Methods, devices and computer programs for determining information which enable a mobile station to identify which resources are allocated to the mobile station, EP2559187
[19] Systems and methods for load balancing of modular information handling resources in a chassis, US9092022
[20] Information analysis device, information analysis method, and information analysis program, JP2018032304