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Competence's Theorem: Solving Problems of Water Utilities

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ABSTRACT

This article as a whole introduces a competence's theorem as scientific cybernetic ideology underlying the optimal regulation of the public services or utilities. In practical applicability, the article considers the most important water utilities, where two specified symptomatic paradigms (non-revenue water and service regulation modeling) that seem to be different have common problems related to the neglecting of the basics of public utilities regulation such as information theory, system theory and cybernetics. The competence's theorem demonstrates that only a model of computing machine being isomorphic to legal State could be an optimal good regulator of the public utilities.

Keywords: Competence's Theorem, Solving Problem, Water Utilities
JEL Classifications: L95, Q25

1. INTRODUCTION

The public utilities are such comprehensive bedrock of either State providing resilience of the industry and humans. Historically, that resilience had been required to arrange public utilities in viable public service in order to save and develop ones for next generations thereon. In turns that public utilities as public service system require the optimal system regulation.

It is logically understandably the public utilities' development cannot be driven by deductions of the persons being beyond of practical field although they have university's scientific and/or engineering high skills.

In order to implement conceptual solutions towards optimal regulation the practical engineering have to be based on such pillars as undoubted scientific ideology (efficiency no greater than 100%, moving speed no greater than light speed, thermodynamics and Newton laws, Pythagorean theorem), scientific platform (cybernetics, information theory) and engineering platform of academic disciplines (e.g., communications system engineering, mechanics etc.). In our case, scientific ideology defines a purpose; scientific platform defines the ways to achieve the purpose while the engineering platform defines the techniques thereon which certainly prove why it so and not otherwise.

This article suggests the competency's theorem as a cybernetics scientific ideology defining a competent framework of optimal regulation of public services or utilities where cybernetics and information theory form a scientific platform; communications system engineering forms the engineering platform of optimal regulation of the public utilities. If classic cybernetics as scientific platform had defined what is a good regulator of a system then competency's theorem defines who has necessary and enough competence to be that optimal regulator.

The lack of even one pillar leads to wrong development of the concepts, problems and solutions. This may be evident by the problems that have not been resolved during the period, allowed for making a decision, called *symptomatic paradigm*. This makes it possible to formulate a trivial "cold-cases hypothesis," that is what we think as a problem is either not a problem, or can be applied to another system, or its solution is a result of incompetence such as lack of pillars.

This article confirms this hypothesis by investigating the most important water utilities, where two symptomatic paradigms - non-revenue water, NRW and so-called service regulation modeling - that seem to be different, but intersect could be allocated as consequence of aforesaid incompetence.

Currently, there are scientists studying these paradigms (Water Industry Act, 1991; Van den Berg, 1997; International Water

Association, 2003; Baietti et al., 2006; Farley, 2008; Frauendorfer and Liemberger, 2010; Berg, 2013; 2015; Hughes, 2013; The Regulation of Water Services in the EU, 2013; Gomeza et al., 2014) and references therein).

NRW has been declared as a pressing problem that has to be conceptually solved. The International Water Association (IWA) defines the consolidated position thereon and points on the apparent and real NRW components (International Water Association, 2009). However, NRW's reports provide no clear answer on why NRW has appeared and still exist. In fact, there was no such notion several decades ago. The researchers and players of the water utilities market bypass this question. The scientific deductions thereon are nonplusing the practical engineers.

It is well-known that water utilities infrastructure (WUI) transfers water using techniques of the water flow produced by water pressure or/and water level differences. Thus, it should be defined certainly whether the water delivered e.g., through water tower is NRW or not. Naturally, WUI has pipe breaks, muff/sealing leakages, but those cannot be the matter for 10 years of dealing with. This can lead to the fact that even predicted water demands might be transformed to NRW.

The paradigm towards the service regulation modeling has a distinction between policy functions and regulatory functions that are not always clear-cut. In other words, there are opposite tendencies to privatize water utilities or provide State-owned regulation thereon. There are critically considered the public, combined public-private and private models regarding water utilities' regulation depending on who represents those researches.

It should be noted that only the State guaranties the Human Rights on Water. On the other side, invention entrepreneurship is a driving force of (any) water (public) utilities development.

There are many propositions and reports around the water utilities regulation in the scope of best practice and experience. However, these studies are mainly theoretical, since there is no any scientific ideology defining direct mechanism combining the existing water utilities with the notion of optimal regulation.

It seems clear that referred sources only confirm a tendency towards the formation of municipal and national corporations, such elites, focused on water supply. These elites have the interior corporation interests and deny the mentioned basic pillars towards optimal regulation.

That is argued by a cybernetic understanding of a system, where the viable system has to be completely defined and covered by feedback for stability (Ashby, 1956). In referred sources, water utilities are not defined completely as a system, since water consumers, WUI manufacturers and legal area where water service takes place are not mentioned in the definition inducing that that called in cybernetics as "conditional variety" (of the acts) that defined in cybernetics as "conditional enthropy" applying to information. The water utilities corporations operate water while consumers, water infrastructure manufacturers and even municipality have no interests thereon. Thus, there is no real possibility to implement efficient solutions when it comes to optimal regulation. It is obviously the symptomatic paradigms tend only to infinite discussion around public utilities.

The main purposes of this article are:

- Formulating the basic pillars that would exclude the symptomatic paradigms and transform them into solvable problems where perfect understanding of these problems is required;
- Introducing an optimal regulation model of the public utilities based on the basic pillars rather on personal deductions.

Competence's theorem introduction requires "to recover initial settings" by referring to studies of such great scientists as R. H. Coase, S. Beer, W. Ross Ashby, Leon Brillouin (Coase, 1937; 1970; 1974; 1988; 1990; Ashby, 1956; Conant and Ashby, 1970; Beer, 1975; 1988; Brilloui, 2004) and references therein).

"To recover initial settings": What does this mean?

Referring to researches on the symptomatic paradigms, we will find out that the first thing that comes to mind is that there is researched "whatever existing" where the scientific ideology, cybernetics and engineering platforms have been neglected independently it is right or no.

Section 2 analyzes the cold-case hypothesis regarding NRW in the light of an approach to identify a problem. The NRW paradigm is considered in the light of water-to-money transformation formula as a key point to estimate real problems of the engineering platform. Since there are deals with money, juridical term "technical casus" has to be introduced:

> *Technical casus generally means the attractive specific solution which has been incompetently interpreted, applied and further led to the wrong scientific concept, and/or violation of legal provisions.*

Studying casuses is an optimal way to understand the origin of the problem. Such approach is applied when there is a need to investigate and solve any problem from few aspects: Politic, economic, legal and techniques preventing unnecessary and unethical discussions.

Section 3 analyzes the metrology casus related to the mechanic water meter design. Metering or metrology problem seems to be well-known as metering error or accuracy etc. However, this article considers it as a result of incompetent application of the magnetic coupling while designing a water meter. In this case, we end with *illegal metering that remains strong for many years* (MacKay, 1983).

Section 4 analyzes the billing casus as negative feedback of system management as the process of the bookkeeping balancing of the water production and consumer bills payment accounts. It is stressed the billing is a source of the system bookkeeping error and it cannot be an appropriate mechanism used for water utilities regulation (Bookkeeping).

Section 5 induces a discussion around NRW with due account for scientific and engineering ethics (IEEE Policies) that led to attempt to expropriate The Human Right to Water in favor of mentioned "water elites" (Mann, 2007).

Section 6 induces a discussion around "who: Human, company or State has competence to be a good regulator when it comes to public services or utilities" in regards to the perspectives of service regulation modeling. Special attention is drawn to Peter's competence principle (Laurence and Hull, 1969; Heylighen, 2014) and its scientific validity.

Section 7 presents a competence's theorem as a scientific ideology for public utilities regulation which generally states: *Only a computing machine being isomorphic to legal State can be a good regulator of public utilities*.

There in prove such major features of cybernetics as "Good Regulator Theorem" (Conant, 1970) and "Law of Requisite Variety" (Ashby, 1956) are adopted in the form of lemma.

Section 8 refers to prior art of the model of a computing machine prototype being able to optimally regulate and control any public utilities. This model is related to the project which was successfully (Tugushev, 2000; 2001) implemented in 1998–2002 (National Medic University, Zaporozhye, Ukraine) and further developed in Ben Gurion university, Israel (2006–2010).

Section 9 presents the conclusions.

2. AN APPROACH TO IDENTIFY A PROBLEM

Water utilities system design involves a synergy of complex academic disciplines and practical engineering in order to investigate its problems using scientific methodology (Coase, 1974; Kiremire, 2011; Problem Solving and Analytical Skills, 2013). There is a complex problem considered in the framework of practical experience while theoretical conclusions have been already made (Coase, 1974).

First of all, practical engineering defines the problem as the *specified system malfunction which should be identifiable, measurable and solvable in the framework of the system's academic disciplines.*

Based on issues highlighted in (Coase, 1974), we will introduce a *problem investigating chain* (PICh) with the following levels:

//symptom//hypothesis//narrow specialized analyzing//solution.

PICh application allows us to consider e.g., NRW in the framework of particular water-to-money transformation illustrated by the following audit expression:

$$Water\ (m^3) \equiv W\ (m^3)\ x\ 1\ (digits/m^3) \equiv W\ (digits)\ x\ 1\ (money/digits) \equiv W\ (money) \quad (1)$$

In this case, NRW is obviously a symptomatic paradigm of problems arising during water-to-money transformation. This audit expression points on three real sources of problems in water utilities system: Leakage (m^3), metrology (digits) and billing (money).

Let's introduce a hypothesis on problems described in detail.

As for the first example: There will obviously be a leakage detected at WUI: Infrastructure quality and its natural aging; but it is not a crucial problem: The infrastructure has to be continuously checked and serviced. Thus, water leakage has to have minimal weight in the PICh.

As for the second example: There is a hypothesis that NRW appears because of unbilled authorized consumers. Well, that is a bit confusing. If there is a consumer then s/he must be authorized according to the water "last mile" infrastructure. If s/he is authorized, then s/he has to possess at least an authorization number adapted generally to local water supply bookkeeping. The authorized consumer cannot be unbilled. S/he may be "unpaid" (payable account) or "sponsored/budget."

As for the third example: There is a hypothesis that NRW appears because of water theft. In this case, it is about a crime in a common meaning. It is appropriate to stress that there should be a red line of ethics realized by the researches and reports.

Therefore, hypotheses regarding the "unbilled authorized consumers," "water theft" ("corruption" as well) and similar issues are not specific WUI problems that were defined early (Farley, 2008; International Water Association, 2009; Frauendorfer and Liemberger, 2010). These are general social-economic malfunctions might be related equally to other complex utilities or high-level system (welfare, local and/or State policy etc.).

Since there are deals with water-to-money transformation, we will stay focused on metrology and billing technical causes which are assumed to be real problems' source of the water utilities.

2.1. Hypothesis: Metrology Casus

The metrology casus is related to mechanical water meter design wherefrom we will try to highlight the technical origin of NRW. Mechanical nodal/district and terminal/consumer water meters have a specific design adopted more than six decades ago (Integrated Metering Technologies, 2017).

Water meters consist of two parts: water flow measurer (e.g., impeller) with a driving shaft and a water flow register-counter with a driven shaft; where the driving shaft magnetically (contactless) is coupled with a driven shaft.

The water flow powers the measurer; its driving shaft rotates the driven shaft of the register-counter through axial magnetic coupling generally of the ring magnets pair.

What is the problem here?

Magnetic coupling is a specific technical solution of mechanical transmission applying to prevent the driving shaft breaking due to overload. Conceptually, such magnetic coupling has a certain nature of slipping, due to which the driven shaft (water flow counter) rotates slower than the driving shaft (water flow measurer).

Magnetic coupling has many-side applications, such as e.g. car clutches wherefrom we can argue the slipping (Magnetic Coupling, 2014).

Every beginning engineer of WUI was surprised to find the district meter displaying a value more than corresponding consumer domestic meters in any case. While a non-controlled and non-computed magnet slipping that at least unpredictably depends on water flow behavior and magnet quality the manufacturers and NRW researchers explain this situation by a "metering accuracy or error."

The following estimation argues that:

> *"In 2007, Ranhill has changed 30 large mechanical meters to electromagnetic meters. This has increased the consumption figures by 20% at some locations*" (Farley, 2008).

This is more than declared "metering accuracy" having 0.5…4% of the metering tolerance (Integrated Metering Technologies, 2017).

If we refer to (Brillouin, 2004), we will face the classic challenge of measurement reliability and apply it to the slipping issue:

> *Approach towards general measurement reliability dependent on thermal fluctuation may be adapted to water measurement reliability regarding the considered slipping.*

Based on patent database analysis, we can assume that Magnetic drive, Patent US 2354563, April, 26 1940 had been became that source of metrology casus (1940).

There, in item 15 is claimed that "*…magnetic muff provides for a non-slip magnetic coupling between the motor driving shaft and the driven register shaft…*"

Patent applications regarding perpetuum mobile and non-slip contactless transmission have no chance to obtain a patent status.

Moreover the magnet slipping is a reason to define mechanic water meters as *illegal measuring tools* that contravene the provisions of legal metrology requirements (MacKay, 1983).

2.2. Hypothesis: Billing Casus

Billing is obviously one of great achievements of civilization together with universally acceptable bookkeeping and thereon a general ledger as well (Hunter and Thiebaud 2003; Bookkeeping).

In general sense, billing is an informative feedback mechanism of negative control-loop providing durability for water utilities system, where *the feedback exists between two parts affecting each other* (Ashby, 1956).

Based on different studies of NRW, we can assume that there is no clear understanding that comparative feedback mechanism, called e.g., *BK* is a bookkeeping process collecting individual bills in some consolidated income account there through general ledger of corresponding accounts and balance sheet:

$$[Ws] \rightarrow [BK] \rightarrow [Wd] \rightarrow [Wm] \rightarrow [Wc]$$

↑   ↓

|____ [*Wb*] _____ |

In this case, the reference *Ws* describes the supplier account; the feed forward *Wd* – water distribution accounts; the regulated object *Wc* – consumer account; feedback *Wb* – the billing mechanism where the consumer's water meter *Wm* is the serviced informative source.

The following well-known closed-loop transfer function expresses the operating mechanism of the water distribution service:

$$Wc = Ws\ x\ (Wd/(1+Wd\ x\ Wb)) \approx Ws/(1+Wb) \quad (2)$$

There the water distributed system passing and saving water through pipes, reservoirs and tower etc. is a passive one with transmission factor 1 wherein is logically argued that $Wd \approx 1$, as the billing feedback is $Ws>Wc$ in *any case regardless of water distribution and billing arrangement*.

The billing enables water supplier to obtain information to make short-term and long-term forecasts in order to at least produce and re-produce water.

In this case, billing induces such transaction cost reflecting NRW because WUI does not produce additional volume of the water since WUI is over-covered by hydraulic negative feedback.

So, while billing has an informative function its arrangement is not appropriative solution when it comes to water utilities regulation.

3. ETHIC DISCUSSION TOWARDS NRW

In the light of metrology and billing casuses, NRW's criticism is not a crowd-pleasing novelty. These are misleading words since the legal and ethical questions cause the negative impact of crucial life-changing. Why?

The non-revenue water inherently raises a concept for water to be the revenue. It should be in mind the revenue belongs to resident or non-resident beneficiary. Thus, we end with a question "Who Owns the Water," since the human right to water had not been written in constitutions of many countries.

The Organization of United Nations continuously declares The Human Right to Water where key milestones generally confirm that "*human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other human right.*"

It is highly unfortunate that corporations and companies (called "water elite") playing on water utilities field try to deny that Water is a Fundamental Human Right by manipulating the meanings of right to water and right to service water.

Referring to scientific and engineering "ethic red line" (IEEE Policies), declared NRW is more a buzzword rather than a concept. There real technic problems are substituted on symptoms related to general social-economic problems causing wrong technical international requirements for WUI upgrade.

Nevertheless, the majority of engineers have applied these wrong technical requirements to design "smart water meters and remove meter reading systems that prevent so-called NRW" (Hardin; Integrated Metering Technologies, 2017) although they have the ethic obligations to society, consumers and profession.

Thus, there are no real reasons to discuss and solve NRW, and in this case, we suggest ending the NRW discussion.

4. DISCUSSION TOWARDS PUBLIC UTILITIES MODELING

Technical problems such as metrology and billing casuses are those examples impacting on political, economic, legal and technical aspects of water utilities wherein there is no legal fair trade while water utilities' players violate the legal and ethical standards.

This motivate to discuss firstly such water utilities management system which solves said technical casuses in wide political, economic, legal and technical aspect, and secondly who (State/company/human) is able to solve that in the context of practical economics.

Conceptually the State does not consider the profit as revenue-expenditures difference (Sovereign State Law and Legal Definition; Martinussen). The State's budget (i.e., Annual Financial Statement) presents the independent sales revenues and spending for a financial year, where only certain types of revenue (e.g. various taxes and fees) and expenditures (e.g., programs) are approved. There are the State programs focused on providing viability for the State industry and population.

In the world of economic management, there are multi-side opinions that State cannot be efficient in terms of regulation and where only the private companies or corporations providing high-quality services (invisible market hand) are such.

In contrast to the State, the company is the profit-making structure. The company's bookkeeping reflects any its activity, where revenue (black) side and expenditure (red) side are taken into account (Bookkeeping). The company's objective profit is the revenue-expenditures difference. The holy purpose of each company is "to be in black and not to be in red." We will make a contribution to the discussion by referring to (Coase, 1974).

On the other side, company's purposefulness and innovative entrepreneurships are the driving force of any technical development which is contrasted to State's regulatory capabilities and induces considerable controversy over several hundred years with key question of "who is there capable to regulate economics."

However, we must take in mind that State, government, company and various State-run and private institutions have abstract nature (kind of a signboard on the road). In their scope, only a human and its professional activity have real measurable nature (equipment, buildings etc.).

It will be logically to draw special attention to the "*Peter's principle*" (Laurence and Raymond, 1969). It is often criticized and unjustly not considered as a scientific pillar while it acquires scientific validity, in light of the discussion, generally stating (Heylighen, 2014): *"…In evolution systems the development of any well-functioning thing, idea, people tend to be promoted up to the limit of their adaptive competence."*

The competence is represented by many researchers as such background paradigm (in opposite to leadership). However, the following cybernetic deduction points on scientific validity of the Peter's principle (Ashby, 1956. p. 245):

> *"The change in the point of view suggested here is not unlike that introduced into statistics by the work of Sir Ronald Fisher. Before him, it was taken for granted that, however clever the statistician, a cleverer could get more information out of the data. Then he showed that any given extraction of information had a maximum, and that the statistician's duty was simply to get near the maximum — beyond that no man could go."*

So, in any case, humans and their activity are such as positive as negative competent force driving the mentioned institutions and public utilities.

Based on the above, we will formulate the "*competence's theorem,*" which defines who can be good regulator of public (water) utilities.

5. A COMPETENCE'S THEOREM

Let's make an attempt to formulate a competence's theorem for public utilities (hereafter public and water utilities are interchangeable):

> *Certainty, if human's incompetence induces the regulating transaction cost of the public utilities then only and only the computing machine being isomorphic to legal State could be a good regulator of the public utilities and reduce the regulating transaction cost to zero excluding, in turn, the human incompetence impact-factor.*

In order to prove the competence's theorem we will adopt the cybernetics basic theorems and deductions in the form of lemma (Ashby, 1956; Conant and Ashby, 1970).

There is at least well-known good regulator theorem conceived by Conant and Ashby (1970) that is central to cybernetics and states that *"every good regulator of a system must be a model of that system."*

The Good Regulator theorem had been proven by adopting the W. Ross Ashby's Law of Requisite Variety (Ashby, 1956) which, in turn, generally states: "*The perfect controlling can be provided only if the variety of means of the controller (in this case the entire controlling system) is at least not less than the variety of the states that it controls.*"

In light of modern smart technologies, we can interpret the general phenomenon of regulation in terms of communications and select a simple one presented in (Ashby, 1956. p. 210):

[D] → [R] → [T].

There is a set of interior-exterior disturbances D, the regulator R, and regulated system's variables T related to considered water utilities.

In this interpretation, "*the Law of Requisite Variety states that R's capacity as a regulator cannot exceed R's capacity as a channel of communication. In this form, the law of Requisite Variety can be shown in exact relation to Shannon's Theorem 10, which states that if noise appears in a message, the amount of noise that can be removed by a correction channel is limited to the amount of information that can be carried by that channel. Thus, its "noise" corresponds to our "disturbance", its "correction channel" – to our "regulator R"* (Ashby, 1956. p. 211).

In order to consider the corresponding capability for a human, company and State to be good regulator, we will express the disturbance capacity and regulating capability in identical measured units.

The disturbance and regulation are defined as opposite poles of the same informative event and activity described through territory, time and humans in scope of regulating and controlling functionality: (e.g.) There should be installed additional smart sensors; increased pump power, disposed laboratories or industry, etc.

The territory is a set of geographic coordinates (longitude and latitude); time is a set of *time's bits*.

The human acting in the scope of any institution represents a capacity of *skilled activity* expressed in scheduled *time's bits* required fixing the some disturbance which might be transformed to *money bits* (such as *hourly wage)*.

The humans are grouped into company (e.g., sole proprietor, private or State-run company). The company operates within operating borders of some public utilities, and according to bookkeeping, the company represents specific summarized skilled activity within the public utilities borders.

Each public utility represents the site of the human consumers and companies operating therein.

Thus, utilities' nature might be estimated in identical measured units with disturbances therein and regulating capability thereon by the following inter-transforming informative expressions:

B(Kbytes) x 1(money/Kbytes) ≡ B(money) x 1(Kbyte/money) ≡ B(Kbytes) – communications,

E(kWh) x 1(money/kWh) ≡ E(money) x 1(Kbyte/money) ≡ E(Kbytes) – electric utility,

$W(m^3)$ *x 1*$(money/m^3)$ *≡ W(money) x 1(Kbyte/money) ≡ W(Kbytes)* – water utility and

H(money)≡ H(money) x 1(Kbyte/money) ≡ H(Kbytes)– consumer's informativity (3)

Each of the public utilities and consumers represent the informative communicating node with corresponding informativity *B(Kbytes)*, *E(Kbytes)*, *W(Kbytes)* and *H(Kbytes)*.

Obviously, each legal state has certainly maximal informative capacity in its geographic borders regardless of interior and exterior factors. There are sets of geographic coordinates, authorized humans (population) and money, called *state's informativity*, related to gross national product. Regarding water utilities the legal State (has to) provides Human Right to Water restricting the requisite variety of various institutions (Ashby, 1956. p. 13).

All of mentioned public utilities share the informativity of state's population *H(Kbytes)* that might be called *gross utility product*.

The public utilities operate within State's nation borders, companies operate within the public utilities and humans act within companies' borders while the company may have a status of sole proprietor or national monopoly (Coase, 1970).

Hence, a human has minimum capability to fix the disturbances because of limited skills, single status, professional tasks and life schedule. Despite the fact that a human might have personal high management skill (leadership), (s)he still has the minimum capability because there is maximal (inter-humans) conditional variety.

A company reduces the conditional variety of the humans' acts due to "nature of the firm" (Coase, 1937). The company, however, has the restricted capability to fix the disturbances because the company has the higher level (inter-companies) of corresponding conditional varieties ant same statement is applicable for set of public utilities as well.

The State's capability (territory, informativity) represents the comprehensive communication channel with *R ≡ (Rb, Re, Rw, Rh)* and *T ≡ (Tb, Te, Tw, Th)* shared by various public utilities whose regulating and controlling capabilities regarding disturbances *D ≡ (Db, De, Dw, Dh)* are stochastically switched therein at least geographic coordinates and consumers' informativity (see expression 3):

[D ≡ (Db, De, Dw, Dh)] → [R ≡ (Rb, Re, Rw, Rh)] → [T ≡ (Tb, Te, Tw, Th)]

We can certainly confirm that the throughput of State's comprehensive communication channel is higher than the summarized regulating and controlling capacity of the public utilities and provides well-known "non-blocking switching" which might be embodied in actual State-run shared regulator. The shared capability of this regulator allows it to solve the problem of insufficient information or conditional varieties.

In light of "good regulator theorem," the State-run regulator always is isomorphic (expression 3) for each of the regulated utilities, where the set of population and its activity are isomorphic to the same set of skilled humans grouped into companies and utilities within the same geographic coordinates.

Obviously, the variety of regulating informative activities of each human cannot be greater than the variety of a particular company. The same statement is applicable for the following pairs: Company versus utilities and utilities versus state.

Concluding: Only the legal State has necessary and enough Requisite Variety in order to be a competent good regulator for various public utilities, and particularly water utilities.

As the state is abstract in nature, then it shall be "*embodied in actual machine*" (Ashby, 1956), as the expression (3) is processed by a computer.

The competence's theorem supports the classic cybernetics platform (Beer, 1975. p. 14, 15):

> *"Using a Computer according to the Cybernetic Principles…"*

In opposite to widely spread opinion, the state and government are not interchangeable meanings, since the government is only institution of human-officials with certain minimum of Requisite Variety to solve disturbances and conditional variety restricting to optimally regulate a set of the public utilities.

We contribute to modern and future practical cybernetics in field of public utilities management by developing a state-run shared computer as an actual territory-deployed gigantic multi-core machine operated under state-run operational system, namely – by introducing the concept of *"living inside a computer"*:

> *Every part of the controlling (institution) and controlled (public utilities and consumers) structures are in equal rights associated with the computer and processed therein through their valid driver previously legally installed into the (state-run) operational system. The operational system, in turn, processes the expression (3).*

This state-run shared computer will allow the state acquiring real nature excluding any human impact-factor (hereafter the meaning state and state-run shared computer are interchangeable meanings in framework of public utilities regulation).

We shall stress that sovereignty factor for legal State is important in this cybernetic sense (Beer, 1975. p. 15). As a consequence of the competence's theorem regarding the state-run shared computer, we might confirm the following.

5.1. First Consequence of the Competence's Theorem

In order to be a good regulator the legal state has to own the sovereign minimum that includes the responsible authority to the set of geographic coordinates and consumer's informativity.

We have called it the *technical sovereignty*.

Technical sovereignty adaptation allows formulating the manageable approach towards optimal service regulation modeling as consequence of competence's theorem.

5.2. Second Consequence of the Competence's Theorem

If humans-state-public-private-run institutions legally share the state-run shared computer in framework of the technical sovereignty in order to regulate and operate the public utilities then this regulation will remain optimal in any case independently on legal status of those institutions.

We have called it the *technical legality*.

The competence's theorem contributes toward the Peter's principle in a way that it has strong scientific validity in relation to human behavior during the regulation process. Thus, the Peter's principle might be generally confirmed as a consequence of competence's theorem:

5.3. Third Consequence of the Competence's Theorem

Regarding the Peter's principle the thing's, human's, company's and State's competence is defined by their requisite variety maximum as the capability's degree with respect to regulate the corresponding disturbances' capacity.

In light of the information theory, state-run shared computer might be studied in the scope of a system and information entropy and negentropy (Brillouin, 2004).

Such system as public utilities is part of a larger informative and isomorphic system – the State. Hence the public utilities' technical means installed into the State-run computer acquire more informativity when their information entropy (disturbances, human impact-factor, and conditional variety) is reduced providing optimal regulating capability.

In scientific synergy applying the information theory to use State-run computer for practical measuring and regulating, we can formulate the applicable consequence of the competency's theorem defining the competent informative node (Brillouin, 2004).

5.4. Competent Informative Node

The competent informative node has to be active with reference to measured and/or regulated system in order to exclude informative disturbance inserting negentropy therein.

Explaining: It is understandable that water meter reduces the water informativity while extracting the information about water flow, and thus, make informative disturbance. The water meter, naturally, has a hydraulic resistance that affects water flow, but we do not discuss it.

Perfect water utilities management requires the complete informative reliability regarding the "water-digit-money-water" transformation. The greater amount of information we want to know to manage water utilities perfectly the higher water informativity is required. If such informativity comprises the water flow pressure/head then WUI shall provide more water informativity, namely – the informative over-supply resulting in a sign of water loss.

Thus, water meter measuring the water flow has to increase or compensate the water flow pressure/head loss inside the water meter to preserve water informativity i.e. to be "active competent one".

The concept of "competent informative node" supports the cybernetics platform as well. It is considered as *a requisite variety limitation (*Ashby, 1956. p. 13).

6. TOWARDS STATE-RUN SHARED COMPUTER

The embryo project of the public utilities regulation based on a cybernetics platform had been implemented and run successfully in 1998 – 2002 in National Medic University, Zaporozhye, Ukraine.

At that time the municipal water utilities were managed by specific municipal water operating consortium. There they were concerned about the currently called NRW, where complete analysis has shown the mentioned "billing casus."

Our solution was *trivial on the paper*. We had considered that billing should be eliminated while the feedback – rearranged (Figure 1), (Tugushev, 2000) in order to transform it in framework of specific municipal bonds (utilities munis):

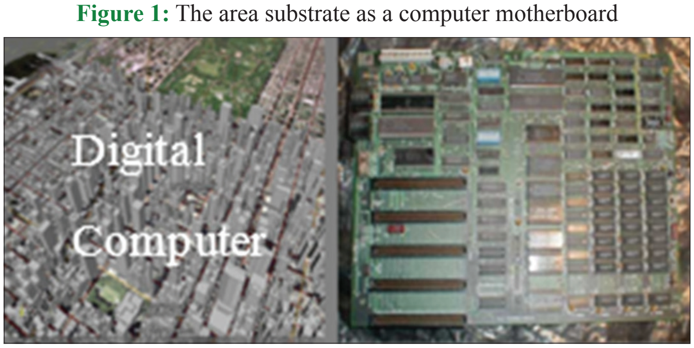
[*Wc*]→[*BK*]→[*Wb*]→[*Ws*]

↑ ↑ ↓

|____ [*Wm*] ← [*Wd*] ____ |

In the proposed scheme the regulated object *Ws* is supplier's account; the feedback. *Wd* – water distribution account is transformed to be the feedback. *Wc* – complete consumer's informativity regarding its water consumption, bonds and money where consumer's water meter. *Wm* is the controlled informative source; the feed forward. *Wb* represents electronic water munis market, the comparative feedback mechanism. *BK* represents the legally shared online bonds bookkeeping database.

Figure 1: The area substrate as a computer motherboard



Thus, we have introduced a simple description of the expression (3) illustrating the regulation concept:

> *Consumer invests water through money; water supplier returns the money through water.*

There the water distribution system remains passive with transmission factor 1: $Wd \approx 1$. However, munis market allows providing $Wb > 1$ through maturity regulation.

The following well-known closed-loop transferring function expresses the introduced water utilities regulation as:

$$Ws = Wc \times (Wb/(1+Wd \times Wb)) \approx Wc \quad (4)$$

Where: *Bookkeeping balance Ws ≈ Wc is saved in any case regardless of water distribution and munis market arrangement.*

In order to process the expressions (3, 4) there had been designed a prototype of State-run shared computer called area deployed computer (ADC) which was not an abstract model; it was a real multi-core computer (Figure 1) wherein the National Medic University campus had been used as such legal State prototype and its urban area had been adapted as such motherboard of said ADC.

In 2006-2010 the ADC's architecture has been researched in framework of the PhD in Communications System Engineering Dep., Ben Gurion University, Israel (Tugushev, 2009).

7. CONCLUSIONS

This article as a whole has presented the competence's theorem which has filled the ideological void and allowed forming scientific cybernetic ideology to understand, solve and develop optimal regulation modeling of public services or utilities. This article mainly concludes that to develop the public utilities where different State and private perspectives are collided in politics and economic aspects there are required scientific ideology. A lack of one leads to wrong trend in public utilities development that will have a crucial impact on human life. In order to prove this conclusion the article has considered the water utilities' cold-case symptomatic paradigms such as non-revenue water and service regulation modeling. The article through cybernetics platform and the competence's theorem suggests the public utilities' cybernetic regulation model where the public utilities' technical means are installed into the computing machine being isomorphic to legal state which could be a good regulator of any public utilities excluding thereon conditional variety and informational system entropy. As a regulation environment, prototype's model illustrated in the article and called the Area Deployed Computer contributes to cybernetic modeling of the public utilities. ADC design and operating capabilities are within the cybernetics concept positioned in opposite to any Internet-based communications technologies. In light of practice, it will be optimal to establish the research testing area such as "*public utility's collider*" in order to standardize the new regulation environment since it is a computing machine. There is introduced the following development concept in the framework of globalization engineering: ADCs can differ, although they should process data in a same way.

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