Business Management of e-Infrastructure

V. Kisimov, K. Boyanov

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Abstract. *The paper presents a method for Business management of the services in the e-Infrastructures. The method offers 4 new types of services and a Conceptual ICT architecture, enabling transformation of infrastructure functions into business managed services. A set of services are proposed in accordance with the user's business needs, applying the formula „BusinessCustomise-Use-PayWhatUsed".*

1. e-Infrastructure - an EU Phenomenon

The Electronic Infrastructure (e-Infrastructure) [1] is defined as a set of EU research activities focused on ICT-based infrastructures and services across a broad range of user disciplines. It aims to empower researchers with an easy and controlled online access to facilities, resources and collaboration tools, bringing to them the power of ICT for computing, connectivity, storage and instrumentation. e-Infrastructure fosters the emergence of e-Science, i.e. new working methods based on the shared use of ICT tools and resources across different disciplines and technology domains. Furthermore, e-Infrastructure enables the circulation of knowledge in Europe online and therefore constitutes an essential building block for the European Research Area (ERA). The Digital Agenda for Europe [2] initiative is one of the seven flagships initiatives of the Europe 2020 Strategy [3] for smart, sustainable and inclusive growth. It recommends sufficient financial support to joint ICT research infrastructures and especially to develop e-Infrastructures.

2. Goals of the Paper

The purpose of the paper is to present a method for Business management of the services in the e-Infrastructure, making measurable and accountable each service, as well as configuring each service according to the current business needs, applying the formula „BusinessCustomise-Use-PayWhatUsed".

As evolution of the „flexible" and „agile" infrastructure, the current paper defines an infrastructure service, which can be tuned and modified according to present business needs, defined by the present running business processes. The client of the e-Infrastructure (individual or corporate) will have the opportunity to „adjust" a set of available services to the business process which has to be run, to identify the quality of the required to provide services, and to pay according to what have been used: the customisation of the e-Infrastructure services; the needed quality; and the level of usage of the infrastructure components in those services. The payment is designed to be on prepaid or credit base models.

3. Essence of the Current Level of the e-Infrastructure

Every day the need of e-Infrastructures and their services is growing. Scientists from many knowledge areas solve more and more scientific problems with the existing e-Infrastructure services. With this raised interest, the complexity of usage of e-Infrastructure is increasing. Many academic and industrial researchers share „virtual communities", federate and exploit the collective power of European scientific ICT facilities, such as GEANT Research network, GRID infrastructure, Supercomputers infrastructure, and Research data infrastructures. Based on the shared principle, the resources of the e-Infrastructures are becoming less expensive, for example, the price of network connectivity per 1 Mbps per month is going from $95 (for a middle level Data centres with about 1000 servers) to $13 (for big Data centres with about 50 000 servers) [7]. The utilisation model of the European research infrastructures shows that the users are mainly the institutions, providing infrastructures (only 30% of the users are not-providing institutions); while the requests for services are more than two-time the available resources [4]. This utilisation model demonstrates the needs of more and more infrastructure resources, which have to have a complex business model for delivering and payment of those resources - operationally complex model (needing monitoring and management of performance, availability, duration and quality of the resources) and financially complex model (needing to provide not linear by time scalable payment, payment of what have been used, and payment according to the provided technical quality). It is interesting to mention that the application areas of the e-Infrastructures do not cover all sciences, but with preferences: Social sciences and Humanities; Astronomy and Astrophysics; Biomedical and Life science; Environmental science; Energy; Chemical and Material science; Physical science and Engineering; and Computer and Information science [4]. It has to be mentioned that the Economical science is not seen between the sciences heavily using the e-Infrastructure. This can be explained with the sequence nature of the economical models, which cannot use the focus values of the parallel computations offered by GRID computing or by High Performance Computing supercomputers - core resources of the e-Infrastructures.

The e-Infrastructure Reflection Group (e-IRG) has been created in Europe with the mission to pave the way towards a general-purpose European e-Infrastructure [5], and to enable flexible cooperation and optimal use of all electronically available resources. The e-IRG was founded to define and recommend best practices for the pan-European electronic infrastructure efforts. It develops a special direction for e-Infrastructure development - providing of services. This means the e-Infrastructure is not offering the use of technology products, but use of services as a unit for utilisation and a unit for payment. These services have to be like commodity services, with policy and interactively defined request for use, which during the years have to be standardised. The most used 14 services in the e-Infrastructures are presented in *table 1* [4].

Table 1

#	Service	Utilisation
1	Grid Computing	52.3%
2	Supercomputing	27.0%
3	Visualization	20.7%
4	Simulation	24.8%
5	Data management tools	38.7%
6	Data analysis tools	31.1%
7	Data collection	32.0%
8	Online storage	29.3%
9	Collaboration tools	27.9%
10	Remote access to research instruments	17.1%
11	Individual support / advice	21.6%
12	Applications ported to the e-Infrastructures	34.7%
13	Online digital materials for research	9.5%
14	Others	9.5%

Table 2

#	Scientific results	Percentage of influence
	Quicker finishing the research	75.8%
	Creation more scientific results	64.9%
	Creation scientific results with lower price	63.5%
	More accurate researches with higher quality	64.5%
	Better access to research resources	77.7%
	Better result treatments	70.4%
	Working on new scientific problems	75.1%
	Creation more scientific publications	42.9%

The influence of the e-Infrastructures on the scientific results can be presented in *table 2* [4].

4. New e-Infrastructure Services

The European Commission has developed 4 types of services for the e-Infrastructures:

- Network services, including: additional TCP/IP services; Levels of Quality of services over the „best efforts"; Accurate prioritisation, measurement and payment; User-controllable dynamic quality of the network services.
- High Performance Computing (HPC), including: Optimal design of processes; Application for SME; Student education in HPC application design.
- Using of common computing resources, including: GRID computing resources; resources in the Cloud.
- Data services, including: Models and algorithms of data manipulation under a form of services; Data-intensive science; services based on metadata.

The European approach presenting the infrastructure as set of services is related to service management, because a

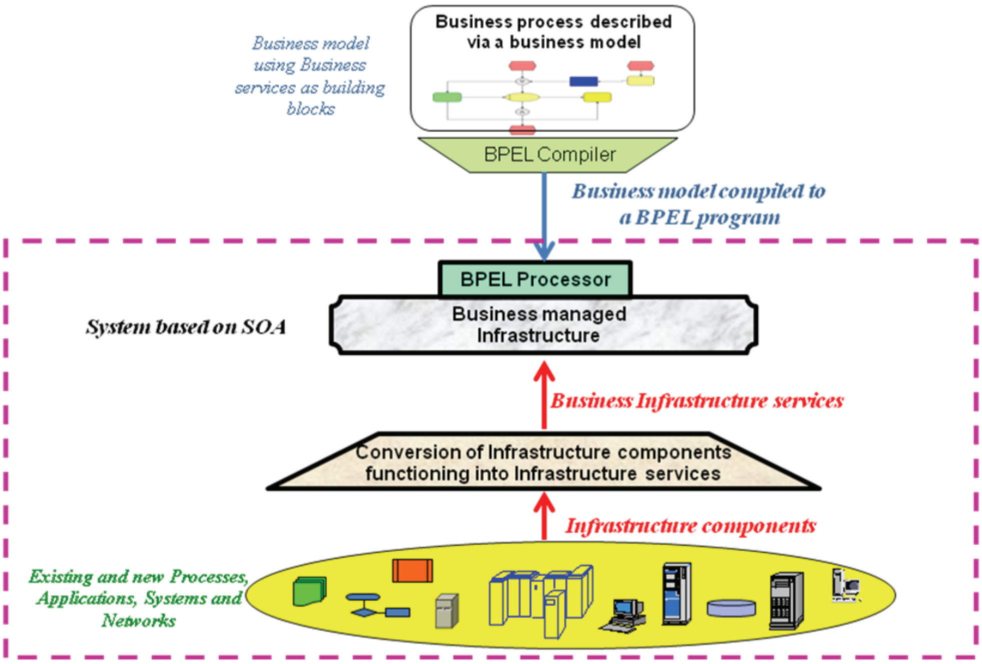

Figure 1. ICT architecture for transformation of infrastructure components into business services

service can be identified and managed by computers. The availability of the infrastructure services offers the possibility to use Service Oriented Architecture (SOA) as a tool for management of the infrastructure. On this base, we have developed new e-Infrastructure services, extending the infrastructures services and proposing new way of management - business management.

The purpose of offering new services is to enable small infrastructure providers to participate in the e-Infrastructures and to use available infrastructure components not-used at a particular moment (like university or corporate servers and computers during the not-active period of the day, or leave some numbers of available computers to be used in the e-Infrastructure, or afford the opportunity some not used parts of virtual blade servers to be available for the e-Infrastructure, etc.).

The purpose of the offering of new business management to the e-Infrastructure is to introduce business evaluation parameters to the technical infrastructure, aiming to make the e-Infrastructure a commodity business service, involving some business characteristics into the scientific research process.

The new, proposed e-Infrastructure services are the following:

a) Componentised computing resources, including: PC/Server with appropriate computational power; file space with appropriate maximum size and type; database space with appropriate maximum size and type; programs which are available for activation.

b) Value-added Network services, including: ratio quality/price (based on technical parameters, bandwidth utilisation, quality of multimedia data and QoS); Network management on application messages level.

c) Central management of the services with implementation of billing system with the principle „PayWhatUsed“ (pay only for the used service, for the period of utilisation).

d) Configuration of the required infrastructure services according to the business processes, which will use the e-Infrastructure, implementing the principle „BusinessCustomise“ (customisation of the e-Infrastructure services and the level and quality of those services according to electronically described business processes).

The first two new proposed e-Infrastructure services are pure technical services offering small infrastructure providers to participate in the e-Infrastructures. The new proposed services - c) and d) are related to real business management of the e-Infrastructure.

5. Architectural Solutions

The role of the ICT Architectural solutions is to turn the functioning of different e-Infrastructure components into services, which are accessible and can be activated via a special program, in a similar way like activation of Web services.

5.1. Conceptual ICT Architecture for Transformation of Infrastructure Functions into Business Managed Services

Generally, the Web services are managed using SOA and a program is executing, activating one or other Web service. In the case of the proposed Architectural solution, SOA is used, while the program running in the SOA has logic for execution of an appropriate business process.

The conceptual ICT architecture for transformation of infrastructure components into business managed services in presented in *figure 1*.

ICT components exist in each e-Infrastructure, such as program-coded-processes, business applications, computer systems and networks. Each of these components has functions, which can be accessed or can be activated via different

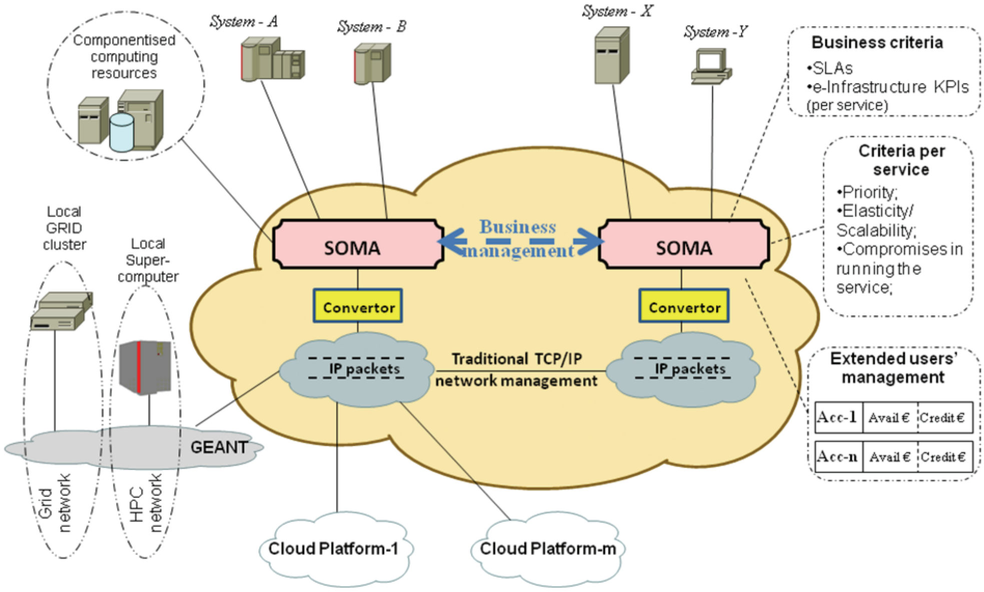

Figure 2. Infrastructure services extending business operation

hardware and/or software ways. In the proposed conceptual architecture, a block called „Conversion of Infrastructure components functions into Infrastructure services" is introduced, which provide ICT solutions for software based access and activation of the functions of those components. Program-coded-processes and business applications could be generalised as programs, which can be wrapped into Web services. Today there are many technologies for manual and automatic creation of upper software layer over a program, which encompasses the program to look like a Web service. Also, there are many technologies for conversion of the functioning of the computer components as PC systems, servers, mainframes, file systems and database systems into services, which these days a massively used in Cloud computing platforms. Through these services, a computer can be „taken" from the computer pool of available computers, its file/database system can be activated or a program can be loaded for execution. For conversion of network functions into a service, an approach for remote changing of configuration files will be applied, through which the functioning of the network devices can be modified, leading to changing the network functioning. The process of changing the network device configuration files can be done via a program system, which from its side can be organised as a Web service. With this way, the network functions can be established, changed and activated as a service.

Once the infrastructure components are converted into services, a SOA architectural block can be applied to use all those services. The SOA works with a program, which uses services. If this program corresponds to an appropriate business process, then the SOA and this program can be logically accepted as an ICT solution, business managing the infrastructure.

A business process can be digitally presented via a graphical digital notation - there are many technologies to do this (for example offered by Oracle, SofwareAG, or IBM). This digital notation is a description of the business process via a business model. In the expression of the digital business model, different business services can be used, which in our case are the services representing the infrastructure functions (business infrastructure services). The digital business model can be converted to a BPEL (Business Process Execution Language) program, via a BPEL Compiler. There are SOA solutions with integrated BPEL Processor, interpreting BPLE program, e.g. the BPEL program manages the operation of the SOA. The big software vendors like IBM and Oracle have similar systems (SOA with BPEL Processor).

The Componentised computing resources are typical example of conversion of infrastructure functions into services with possible business management.

5.2. Conceptual ICT Architecture for Extended Business Operation of the Infrastructure Services

The presented Architectural solution serves to this point to convert the infrastructure functions into business managed services. The proposed next architectural solution has a purpose to present how these infrastructure services can have extended business operation. The conceptual architecture of this solution is given in *figure 2*.

In *figure 2*, the SOA, serving in the process of conversion of the infrastructure functions into services, is logically positioned into the middle level of the infrastructure and we are calling it SOMA (Service Oriented Middleware Architecture). SOMA is used for managing the extended business operation of the e-Infrastructure. The traditional IP packets in the TCP/IP network are transformed via a specially designed device „Convertor" to an application messages, such like SAP message, MQSeries message, JDBC message, etc. (the device Convertor can be designed as a Proxy server with J2EE engine having Communication architecture. Cisco has designed such a device as AON). In this way, the network management is moved from managing of IP packets to managing of application messages, which in fact are business messages. This way of management provides the so-called „Value-added network services“. Through this approach, the GRID computing services and HPC services of the current e-Infrastructure, accessible via the GEANT research network, can be managed with a business meaning focus. Different Cloud Platforms can be connected and also managed in a similar way.

Specific to the proposed architectural solution is the incorporation of Business criteria (SLAs and e-Infrastructure KPIs), Criteria per service (Priority; Elasticity/ Scalability; Compromises in running the service) and Extended users' management. The Business criteria define the quality level of infrastructure services, which an individual user is expecting and paying. The Key Performance Indicators (KPIs) identify measures of user's performance, which are required from the e-Infrastructure. The criteria per service are set of business criteria, which are required from the infrastructure services, having different requirements per service, per user. The extended users' management allows to execute services, for which there is an available financing - either via pre-paid type of financing (using „Available •“), or via crediting (using „Credit •“).

Conclusions

The developed conceptual ICT architecture needs to be evaluated in different conditions and modes of work. One of the possible directions of future work is to create an architectural prototype, and the other is to develop a simulation model. The proposed architectural solutions partially have been prototyped and tested, but for the full evaluation of the architectures, either comprehensive prototype system has to be created, or a simulation model has to be designed. Key issue in the model design is the adequacy with possible real ICT architectures. This condition can be satisfied by entering data either from real existing e-Infrastructures, or from legacy corporate information systems, and after that to provide comparison of the model results with the reality. The follow-up system analysis and the evaluation of different parameters will allow the designer of such architecture achieve effective solution for its needs.

The proposed architecture for business management of e-Infrastructures offers capabilities for using infrastructure components as services, delivering the necessary quality and asking to pay only for what have been used. On top of this, the infrastructure services can be incorporated into business process models, allowing the business process to use only those infrastructure services, which are needed. The proposed architecture can also be used for dynamic incorporation of new infrastructure resources, offering required quality, and asking for a specific payment. These features provide new models for service differentiation and pricing to optimize the Return of Investment of ICT infrastructure.

References

1. European Commission. ICT Research in FP7, e-Infrastructure. Home page. http://cordis.europa.eu/fp7/ict/e-infrastructure/

2. European Commission. Information Society. Digital Agenda for Europe. http://ec.europa.eu/information_society/digital-agenda/index_en.htm

3. European Commission. Europe 2020 Strategy. http://ec.europa.eu/europe2020/ index_en.htm

4. Europe's Information Society. Future Networks 7th FP7 Concentration Meeting, 10-11 February 2011, Brussels, http://ec.europa.eu/information_society/events/ future_networks/concertation/programme/7th/index_en.htm

5. E-Infrastructure Reflection Group. http://www.e-irg.eu/publications/roadmap.html

6. Kisimov, V. Dynamic Business Managed Information Systems. ISBN 978-954-323-444-8, 2008, Sofia, Bulgaria.

7. Armbrust, Michael, Armando Fox, Rean Griffith, Anthony D. Joseph, Randy Katz, Andy Konwinski, Gunho Lee, David Patterson, Ariel Rabkin, Ion Stoica, Matei Zaharia. Above the Clouds: A Berkeley View of Cloud Computing - Technical Report No. UCB/EECS-2009-28, 10 February 2009, Electrical Engineering and Computer Sciences University of California at Berkeley - Reliable Adaptive Distributed Systems Laboratory. Retrieved from http://www.eecs.berkeley.edu/ Pubs/TechRpts/2009/EECS-2009-28.pdf

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Valentin Kisimov *received the Engineering degree in Electronics from VMEI-Sofia in 1970. He received the Ph.D. degree in Computer Science in 1984, the Doctor of Science in Economics in 2009. He is IBM Internationally certfied consultant. He is a Vice Rector, UNWE, Sofia, Bulgaria. Technical skills and competences: Design and implementation of a complex integrated ICT system - Infrastructure architecture, Information architecture, Application architecture, Security architecture.*

Contacts:
e-mail: vkisimov@gmail.com

Kiril Boyanov *graduates the Higher Institute of Mechanical and Electrical Engineering - Sofia in 1958 as a Radio engineer. He defends his PhD (1966) and D Sc(1975) theses in Computer Sciences in St.Petersburg Electro technical State University(LETI) - Russia. He becomes professor in 1982 and in 1989 is elected for Corresponding Member of the Bulgarian Academy of Sciences. During the period 1999-2000 he is professor at the Helsinki Technological Institute. Elected as Academician of the Bulgarian Academy of Sciences, in 2003.*
He undertakes various leadership positions at his professional standing: Director of the Institute for Microprocessors and Instruments, Director of Centre for Informatics and Computer Technology, Director of Institute for Parallel Processing. His area of scientific interests includes: Electronics, Discrete mathematics, Computer architectures, Computer networks, Digital Simulation. K.Boyanov is Bulgarian Representative in IFIP, Member of Bulgarian Union of Automatics and Informatics.

Contacts:
e-mail: boyanov@acad.bg