Easy Communication Environment on the Cloud as Distributed Simulation Infrastructure

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Abstract: - The development of Future Internet and Cloud computing creates new challenges for simulation scientists in terms of enhancing the accessibility to distributed simulation and empowering the researchers from other disciplines. The article tests the operation of simulation communication environment using Cloud infrastructure. The results of the experiment within Amazon EC2 Cloud infrastructure show no significant benefits for Easy Communication Environment users.

Key-Words: - HLA, CORBA, DIS, Cloud, Easy Communication Environment (ECE)

1 Introduction

Simulation nowadays plays an increasing role in situation analysis in research and the assessment of possible solutions in business. Sociotechnical systems deal with technological control as well as the impact of social or natural factors. EC FP7 project No.287119 FUPOL „Future Policy Modelling" (http://www.fupol.eu) aims at a completely new approach to traditional politics. Major innovations like multichannel social computing and crowd sourcing will change the way politicians communicate with citizens and enterprises and take decisions. This will enable governments to gain a better understanding of the needs of citizens. Likewise the FUPOL simulator will have the capabilities to simulate the effects of policies and laws and to assist governments in the whole policy design process. The simulation models and tools of the sociotechnical systems are often incompatible, heterogeneous and territorially distributed and it is especially problematic if domain specialists lack the expertise and specific programming skills to use them effectively. To achieve this, several heterogeneous and territorially distributed models have to communicate and co-operate. The development of Future Internet and Cloud creates new possibilities and challenges for simulation engineering by offering extended access.

This article discusses distributed simulation communication environments as the possible solution aiming at deployment of the simulation services on the Future Internet and the Cloud. Easy communication environment usage is tested within cloud computing infrastructure.

2 Distributed communication environments

2.1 High Level Architecture (HLA)

High Level Architecture (HLA) is a concept of the architecture for distributed simulation models. HLA is a powerful, however complex tool, and ensures interoperability and reuses among simulations. It consists of a)rules that determine federation; b)Object Model Template that defines the format for specifying the set of common objects used by a federation (federation object model); c)their attributes, and relationships among them; d)interface specification, which provides interface to the Run-Time Infrastructure, that can be distributed and ties

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together federates during model execution [16]. HLA is well standardized (IEEE Std 1516-2000, IEEE Std 1516.1-2000 and IEEE Std 1516.2-2000) [17] and could be used for heterogeneous and distributed simulation systems development.

2.2 Distributed Interactive Simulation (DIS)

Distributed Interactive Simulation (DIS) is based on distributed interactive simulation protocol – SIMNET. DIS is an open network protocol standard for linking real-time platform-level war gaming simulations. DIS standard specifies the layout of data to be transferred in network level. Communication packets/data PDUs are laid out exactly as defined in the DIS specifications. DIS Protocol Data Units (PDUs) define syntax (data format) and semantics (rules), for network data exchange and simulation interoperability. Designed to be an environment for real-time data exchange among distributed, computationally autonomous units. DIS has no central control unit for the entire simulation exercise and therefore may be used respecting choreographic interoperability provided in some Future Internet platforms. The development of DIS decreased following the proposal and promulgation of its successor – HLA [2].

2.3 Common Object Request Broker Architecture (CORBA)

The first Common Object Request Broker Architecture (CORBA) includes CORBA Object model, Interface Definition Language (IDL), and the core set of application programming interfaces (APIs) for dynamic request management and invocation (DII) and Interface Repository as well. Also some several features like interfaces for the Basic Object Adapter, memory management and more IDL language mappings exist [3]. Two kinds of the objects exist in CORBA: Servants and Clients. The Servant is an implementation entity that defines the operations supported by CORBA IDL interface. Client invokes operation on an object implementation from Servant [1].

CORBA standard was elaborated for joint communication of the programs written in different languages. To achieve this aim the interfaces of the modules must be specified in conformity with the requirements of the IDL. IDL specifications are accessible for C, C++, Java, COBOL, Smalltalk, language, which made this mechanism well suited enough. Nevertheless, the CORBA environment asks for centralized synchronization that made distributed simulation systems vulnerable, but it is important only in some specific cases [3].

2.4 Web Service

Web Service (WS) is a communications mechanism that allows the client to address server with a request. Web Service communication interface is defined as Web Services Description Language (WSDL), but communication occurs using Simple Object Access Protocol (SOAP), that is meant for structured information exchange. There are two types of WS use: Remote procedure calls and Service-oriented architecture. The drawback of WS is comparably slow operation and relatively greater amount of data that is transmitted. Web Services differ from the distributed object technologies in that they have reverted to an earlier "remote service" model. There is no concept of an object reference; instead a service is defined simply by an end-point that supports various operations [4].

2.5 Some drawbacks of existing communication environments

However to create heterogeneous and distributed simulation models researchers mostly use one of abovementioned communication environments. One of the most influential drawbacks is the lack of ready-made solutions that would allow creating multi-model systems. Unfortunately each case has to be dealt separately, by designing new communication environment among models. Integration of communication environments is not trivial, it is complex and time-consuming, and therefore a software engineer is needed as well as additional funding for the research project. In fact, the accessibility of modelling tools is very limited for domain experts, and this very often leads to mistakes in decision process.

3 Easy Communication Environment – way to the inclusion

To deal with the abovementioned problems concerning heterogeneous simulation modelling systems, a new communication concept was made – "Easy communication environment". The essence of this concept lies in its simplicity – the domain expert is able to "connect" modelling tools without the help of software engineers. Easy Communication Environment has to be reusable and universal at the same time in order to be able to connect as much various modelling tools as

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possible. For more information see Aizstrauts A. et al [5].

The main principles were taken from HLA – communication occurs through broadcasting. The user uses special plugin/extension of simulation tool that allows send/receive data, indicates what data he wants to send/receive. The communication adapter operates on the same computer and it can either register the specified data or sign up for already registered data. So, similarly to HLA, the data is only sent to those, who have signed up for it.

Communication node consists of Communication adapter with embedded data storage, Communication library and simulation Models. The data storage allows storing the incoming data. It is necessary because models operate differently in time, and it may be possible that one model is not able to receive the amount of data sent from another model within a certain period of time. Easy Communication Environment uses XML data format to transfer simulation data requests and responses.

Figure 1 shows the architecture for communication among several Communication adapters in the framework of distributed simulation model, where nodes can be located anywhere geographically.

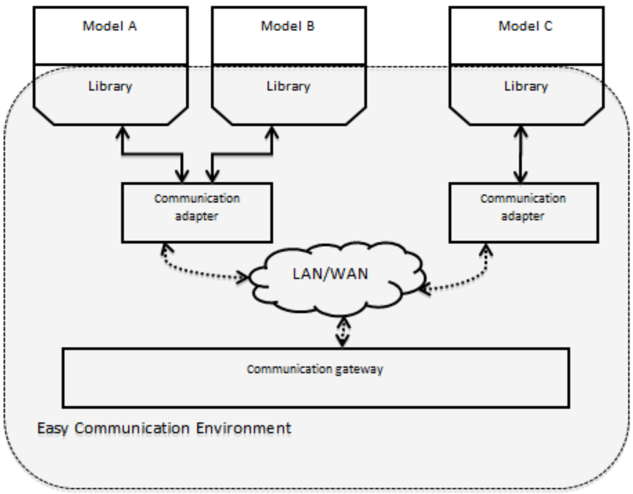

Fig.1. Easy Communication Environment [5].

Communication gateway ensures communication among adapters and it is important that all adapters can be seen by communication gateway. Communication gateway maintains the simulation data registry and data "subscriber" registry. It ensures that data is received by only those adapters that have subscribed to certain data [5].

4 Simulation – One of the Services on the Future Internet and the Cloud

4.1 Future Internet context

It seems that nowadays it is hard to over-emphasize the importance of the Internet and its presence in our everyday routines. Tselentis et al. states that the current Internet designed 40 years ago is today the most important information, service and networking infrastructure providing the mechanisms for the digital society at large to function as an integrated entity [6].

At the same time the increasing dependence on the Internet as a daily tool has tremendous social and economic impact [14]. Within this context a European initiative called "The Future Internet Assembly" (FIA) has been established with the goal to shape the Internet of the future. This initiative, which is backed by a number of European research projects under the EU Seventh Framework Programme (FP7), follows similar activities in the US, Japan, and Korea [8]. The European Commission supports approximately 140 Future Internet projects to a greater or lesser extent and some research of them are related with Cloud (http://www.future-internet.eu/activities/fp7-projects.html). There is a need for both researchers and practitioners to develop platforms made up of adaptive Future Internet applications. Simulation is not an exception, as it can become one of such services in the Future Internet environment [9].

4.2 Cloud-based simulation

Cloud computing is emerging as a novel computing paradigm. A specific feature of it is that computation and storage resources are provided as services. In this way, applications/software can be executed or maintained on the Cloud without the necessity of operating an own local infrastructure. Such a computing model significantly reduces the cost for resource and software management, which is clearly an attractive benefit for small business and research groups. In addition to cost-efficiency, Cloud computing shows other advantages such as on-demand resource provision, supporting legacy codes, service reliability, easy management, and so on [10]. Some well-known commercial Cloud

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solutions are for instance Google's AppEngine, Microsoft Azure, Sun Grid, Aneka, Amazon's Elastic Computing, Salesforce etc. [7, 11].

Cloud computing offers the promise of outsourcing the task of providing and managing execution platform to users while hiding many of the complicated details of parallel and distributed simulation execution. As such, it offers the possibility of making parallel and distributed simulation technology much more readily accessible to the simulation community. As cloud-computing environments become more common, their use for parallel and distributed simulations becomes more attractive [12].

The potential benefits and technical challenges that arise in utilizing cloud platforms for parallel and distributed simulations and a potential solution approach has been studied by Fujimoto, Malik and Park [12]. It has been observed, they argue, that parallel scientific codes executed over Amazon EC2 ran significantly slower compared to execution on dedicated nodes of a cluster. They stress that Cloud environments are often better at providing high bandwidth communications among applications than in providing low latency and this is problematic for many simulation applications that are accustomed to sending many small messages requiring quick delivery rather than fewer large messages requiring high bandwidth alone. Many of cloud environments in general, according to their research, are not specific to parallel or distributed simulation. For example, users must be assured that proprietary and confidential data will be secure in a cloud environment before they will consider such a move [12].

Another research to be mentioned is the one done by Yamazaki et.al. [15] Their on-going work aims at development of cloud-based web service called "Simulation Platform" for multi-scale and multi-modal neural modelling, and they stress that Cloud-based technology simplifies the work of researchers. They also conclude that such a simulation platform has tremendous applications also for more general use in various academic fields, including the peer-reviewing process and adding functionality to online articles. [15]

But one can outline also another major problem, e.g. while the development of different Future Internet mechanisms involves software engineers; they might lack the perception of possible kinds of services and their specific operation in the Future Internet. The end-result depends on many experts from different fields and their collaboration. These experts define what and how should be developed by software engineers from the users perspective. For example, in logistics some specific aspects of RFID, biometrics and GPS data exchange must be respected.

5 Easy Communication Environment on the Cloud

The use of Cloud computing in various fields of research still has to be tested. Also Buyya et al. indicates the need of Cloud computing and other related paradigms to converge so as to produce unified and interoperable platforms for delivering IT services as the 5th utility to individuals, organizations, and corporations [11].

Therefore the aim of this research is to test the Easy Communication Environment architecture on one of available Cloud computing platforms and consider the possibilities for future operations.

To choose among the Cloud platforms, one had to make sure what the requirements regarding the Easy Communication Environment were. Easy Communication Environment is JAVA based, that means that the platform for running Easy Communication Environment must to have JVM (Java Virtual Machine). Another criteria is related with simulation software. The experiment described in this paper deals with two modelling environments – Extend and NetLogo [5]. Extend operates only on Windows and Mac OS X, and NetLogo also on Linux. Accordingly, the chosen cloud solution had to offer appropriate infrastructure rather than a platform. Therefore Amazon Elastic Compute Cloud (EC2) was chosen for this experiment.

Amazon EC2 provides a virtual computing environment that enables a user to run Linux-based applications. The user can either create a new Amazon Machine Image (AMI) containing the applications, libraries, data and associated configuration settings, or select from a library of globally available AMIs. Amazon EC2 charges the user for the time when the instance is alive, while Amazon S3 charges for any data transfer (both upload and download) [11]. EC2 supports RedHat Linux, Windows Server, openSuSE Linux, Fedora, Debian, OpenSolaris, Cent OS, Gentoo Linux, and Oracle Linux OS server instances. Server instances are administered using we-based interface (AWS Management Console) or using Amazon E2 API.

To integrate the Easy Communication Environment with Amazon EC2 three server instances are needed. Two instances operate with simulation models and the third is reserved for the Communication gateway. Additional three Elastic IP addresses for each instance are needed. (Elastic IP addresses are static IP addresses designed for dynamic cloud computing [13]). These IP addresses are used by Communication adapter to establish a connection with Communication gateway. All server instances use Windows Server OS, respectively one runs Extend and Communication adapter, the second - NetLogo and Communication adapter, and the third – Communication gateway. Figure 2 shows Easy Communication Environment on Amazon EC2. To use simulation tools, user must have direct access to model. Therefore the Remote Desktop Protocol (RDP) is used to control simulation models.

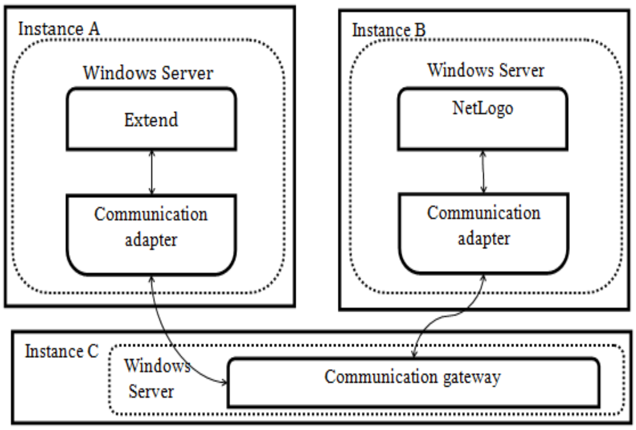

Fig.2. Easy Communication Environment on Amazon EC2.

Amazon EC2 offers „unlimited" server resources to be used for intensive load. Unfortunately Easy Communication Environment architecture in its current stage is not able to use this advantage. It is not possible to make GRID, as each simulation model operates on separate server and this action cannot be divided among several servers.

Easy Communication Environment allows communication among different types of simulation tools, and many of them support a dynamic modeling process with active participation of the user (for example, NetLogo). In this case the use of Amazon EC2 is not beneficial, but is rather inconvenient, because the user has to use RDP. Finally, if the model is deployed on Cloud, then the fact that only one user can work with the model, could also be perceived as a disadvantage, otherwise the great potential of Cloud computing is being neglected.

6 Conclusions

This article discusses the challenges of distributed simulation within the context of different communication environments and the Future Internet development. It proposes and tests the operation of communication environment using Cloud infrastructure. The development of the Internet of Services and Cloud computing creates new challenges for engineering scientists in terms of enhancing the accessibility to distributed simulation and empowering the researchers from other disciplines.

To ensure the communication among different models the user has to apply one of communication environments (HLA, CORBA, WS, etc,) but there are no ready-made solutions that would allow creating multi-model systems. By dealing with communication among models in case-based manner, huge resources are spent on technical issues, not on research.

The concept of "Easy Communication Environment" provides a simple solution where the domain expert is able to "connect" models without the help of software engineers. Easy Communication Environment is reusable and universal at the same time in order to be able to connect as much various models as possible.

The new paradigm of Cloud computing in its way corresponds to the needs of distributed simulation society and is very promising, although recent studies report also some drawbacks as many Cloud environments are not specific to such simulation tasks.

Within experimental running of Easy Communication Environment on Amazon EC2 infrastructure, it was concluded that Cloud computing has no significant benefits for Easy Communication Environment at the moment.

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References:

[1] A. Silins and E. Ginters. “Simulation Data Exchange in Distributed E-learning Environment”, in: Proceedings of the 4th WSEAS/IASME International Conference on Educational Technologies (EDUTE 08), Corfu, Greece, October 26-28, 2008, ISBN 978-960-474-013-0, 2008, pp.138-143

[2] R. Murray, DIS Overview and Version 7 Information, Simulation Interoperability Standards Organization, 2010 http://www.sisostds.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&EntryId=29289&PortalId=0&TabId=105 10.11.2011.

[3] “Welcome to the CORBA Directory.”, Object Management Group, Inc, http://corbadirectory.omg.org/, [accessed 07.11.2011]

[4] Gray N.A.B. 2004. “Comparison of Web Services Java-RMI, and CORBA service implementations”, in Proceedings of Fifth Australasian Worshop on Software and System Architectures, Melbourne, Australia, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.63.1265&rep=rep1&type=pdf#page=60

[5] A. Aizstrauts, E. Ginters, D. Aizstrauta, “Easy Communication Approach for Data Exchange in Distributed Simulation Environment” in Proceedings of the13th WSEAS International Conference on Automatic control, modelling &simulation (ACMOS 11), May 27-29, 2011, Lanzarote, Canary Islands, Spain, ISBN: 978-1-61804-004-6, ISSN: 2223-2907, pp. 34-39.

[6] G. Tselentis et al, Towards the Future Internet, IOS Press, 2009 ISBN 978-1-60750-007-0 p.359

[7] C. Pedrinaci, J. Domingue “Toward the Next Wave of Services: Linked Services for the Web of Data,” in Journal of Universal Computer Science, 2010

[8] D.Hausheer et al. “Future Internet Socio-Economics – Challenges and Perspectives,” in Towards the Future Internet. G.Tselentis et al.(Eds.) IOS Press, 2009 ISBN 978-1-60750-007-0 (pp. 1-11)

[9] E. Ginters, I. Sakne, I. Lauberte, A. Aizstrauts, G. Dreija, R.Maria Aquilar Chinea, Y.Merkuryev, L.Novitsky, J.Grundspenkis, “Simulation Highway – Direct Access Intelligent Cloud Simulator,” in Proceedings of 23th Europen Modelling & Simulation Symposium (EMSS 2011), ISBN 978-88-903724-4-5, 12-14 September, 2011, Rome, Italy, pp.62-72.

[10] J.Tao, H.Marten, D. Kramer, W.Karl, “An intuitive framework for accessing computing clouds,” in Procedia Computer Science 4 (2011) 2049-2057

[11] R.Buyya,Y.C Shin, S.Venugopal, J.Broberg, I. Brandic, “Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility,” in Future Generation Computer Systems 25 (2009) 599-616

[12] M.R.Fujimoto, A.W.Malik, J.A.Park, “Parallel and Distributed Simulation in the Cloud,“ in SCS M&S Magazine – 2010/n3

[13] Feature Guide: Amazon EC2 Elastic IP ddresses, http://aws.amazon.com/articles/1346 [accessed 12.11.2011]

[14] C. Blackman, I.Brown et al. Towards a Future Internet, 2010. “Interrelation between Technological, Social and Economic Trends. Final Report for DG Information Society and Media”. European Commission DG INFSO Project SMART 2008/0049, November 2010, Available from: http://www.internetfutures.eu/wp-content/uploads/2010/11/TAFI-Final-Report.pdf, [accessed 13.11.2011]

[15] T. Yamazaki, H.Ikeno et al. “Simulation Platform: A cloud-based online simulation environment,” in Neural Networks Vol 24, Issue 7, September 2011, pp 693-698

[16] J.S.Dahman, R.M.Fujimot, R.M. Weatherly, “The Department of defense high level architecture,” in Proceedings 1997 Winter Simulation Conference, 1997

[17] VTMÄK, http://www.mak.com/resources/industry-standards/hla--high-level-architecture.html [accessed 10.11.2011]