SIMULATION TOOLS AND SERVICES FOR MOBILE USERS: HISTORY, STATE-OF-THE-ART AND FUTURE

A. Anoprijenko, S. John, H. Al Ababneh

Donetsk National Technical University, UA-83000, Artema, 58, Ukraine
anoprien@cs.dgtu.donetsk.ua
http://donntu.edu.ua

1 VERY LONG HISTORY OF SIMULATION FOR MOBILE USERS

One of main ideas of this paper is a hypothesis that the simulation play an essentially more significant role in a human history and culture than it is usually assumed. On some examples it can be demonstrated that modern computational simulation has ancient prototypes and some artefacts can be interpreted as special simulation tools and environments. As typical examples of ancient simulation tools the "life/world tree" on mammoth bone and megalithical "models of the world" are presented. These artefacts were interpreted earlier as calendars, observatories or "ancient computers". The proposed hypothesis considers the following interpretation as most exact and appropriate: "special computational simulation tools and environments with real-time functions (calendar) and real-world interface (observatory)".

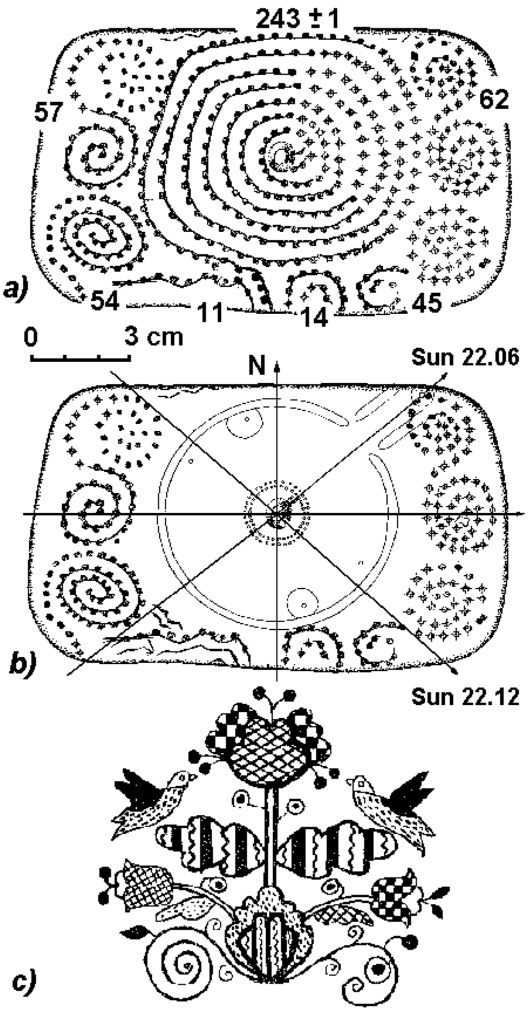

Figure 1. a) Quantitative characteristics of the "life/world tree" elements on the ancient plate from Siberian Malta; b) Plate as microobservatory (in compare with Stonehenge); c) Typical Ukrainian image of the mythological "life/world tree".

We can say now about new science "archaeosimulation" [1-3]. The history of modern study of archaeosimulation begins from researches of Gerald S. Hawkins on Stonehenge more than 30 years ago (Hawkins and White 1966). Hawkins was not only the first who used a modern computer for the analysis of the ancient construction, but also he has declared the existence of "stone computers". Late other megalithic monuments were investigated and described, which were probably used as observatories and special original computers for registration and forecasting of the astronomical events (see, for example, Wood 1978). Almost all described structures can be interpreted as simulation tools.
As well as for modern science for ancient people the various forms of computational simulation were the most powerful means of research and understanding of complex dynamic processes of the real world.

New results described in the given work permit to interpret some other well known ancient artifacts as special tools for simulation.

In the Hermitage in St. Petersburg a small plate of mammoth bone with spiral figures of many dozens of dots is stored. It was found in 1929 in village Malta near the western part of the Baikal lake (Siberia). The age of the plate is more than 15 thousand years.

While stored in the Hermitage the plate was periodically investigated by various scientists. One of the first was a German mythologist Karl Hentze. Hentze interprets spirals of the plate as symbols of the moon phases and even as an image of the whole universe, but without any quantitative analysis. The most careful analysis of semantics and quantitative system of the plate was done more than 10 years ago by Russian professor Larichev (Larichev 1989). His conclusions were as follows: advanced knowledge about the visible movements of the star sky are fixed on the plate, which are a result of exact long-term observation of the Sun, Moon and visible planets. The precision of registration and representation of the information is quite enough for a sure prediction of the lunar and solar eclipse! Larichev has detected the following main elements on the plate:

- solar year: 243+62+45+14 = 365 days;
- lunar year: 243+57+54 = 354 days;
- four-year cycle: (242+63+45+14+11+54+58)x3 = 365.24 x 4 = 1461 days;
- sidereal form of the saros: 242x27,21=6585.35 days =18.61 solar years = 19 sidereal years;
- synodic form of the saros: (54+57+63+45+4)x29.53 = 6585.35 days;
- synodic cycle times for planets:
  - Venus: (54+11+14+45) x 29.53 = 5 cycles;
  - Mars: (62+57) x 29.53 = 4.5 cycles;
  - Jupiter: (63+45) x 29.53 = 8 cycles;
  - Saturn: (57+54+11) x 29.53 = 9.5 cycles.

Additional analysis of the plate as special simulation tool has allowed to determine the following:

1) The Malta plate model permits besides an exact “scientific” simulation of motions on the sky sphere also a simplified pragmatic “calendar” simulation for wide use:

- ≈1/6 of the solar year: 62 days;
- ≈1/8 of the solar year: 45 days;
- ≈ double sidereal month: 54 days;
- ≈ double sinodic month: 58 days;
- ≈ synodic cycle time for Mercury (four internal points of an element “14”): 4 x 29.5 = 116 days;
- ≈ synodic cycle time for Venus (ten external points of an element “14”): 10 x 29.5 x 2 = 590 days.

Then the plate can be interpreted as “model of the world” or “world tree”.

2) The element "14" can be easily used for observation of the female reproductive cycle:
Stage 1: 10 “external” days of barren period followed by menstruation.
Stage 2: (4+4) “internal” days followed by ovulation.
Stage 3: 10 “external” days before menstruation.
Stage 4: If menstruation does not come in time, then it will be necessary to make testy pass of the whole cycle (10+4+4+10).
Stage 5: In case of delay of the menstruation the cycle must be corrected.
Stage 6: If during the test pass of the cycle the menstruation was not, then go to central spiral “242”.
General term of pregnancy is 10+28+242=280 days.
Then central part of the plate can be interpreted as the “life tree”.

3) “Malta plate” was probably wide used special computational tool in ancient society, and it can be interpreted as specific simulational prototype for the famous mythological concept of “life/world tree” (Fig. 1c).

4) Baikal is located on the same latitude as Stonehenge. Main solar and lunar directions for Stonehenge and for the “mammoth plate” coincide. The plate could be used also as a "personal Stonehenge" or microobservatory (Fig. 1b).

5) Such form of fixing and transfer of the information allowed at the initial stage of history of the civilization (more than 10 000 years ago) to accumulate, apply and transmit knowledge without alphabet and another forms of writing.

Other good example of ancient simulation tool for mobile use is so called **Phaistos disk** (Fig.2). This is rectifying archaeological artifact from Crete. It is called the Phaistos Disc and is a small, baked clay disc about five inches in diameter. On the surface of each side of the disc there are incised spirals and within these are groups of hieroglyphic type characters which have never been interpreted [4].. The Phaistos Disc is thought to date to about 1700BC. It is presently in the Heraklion Museum in Crete.

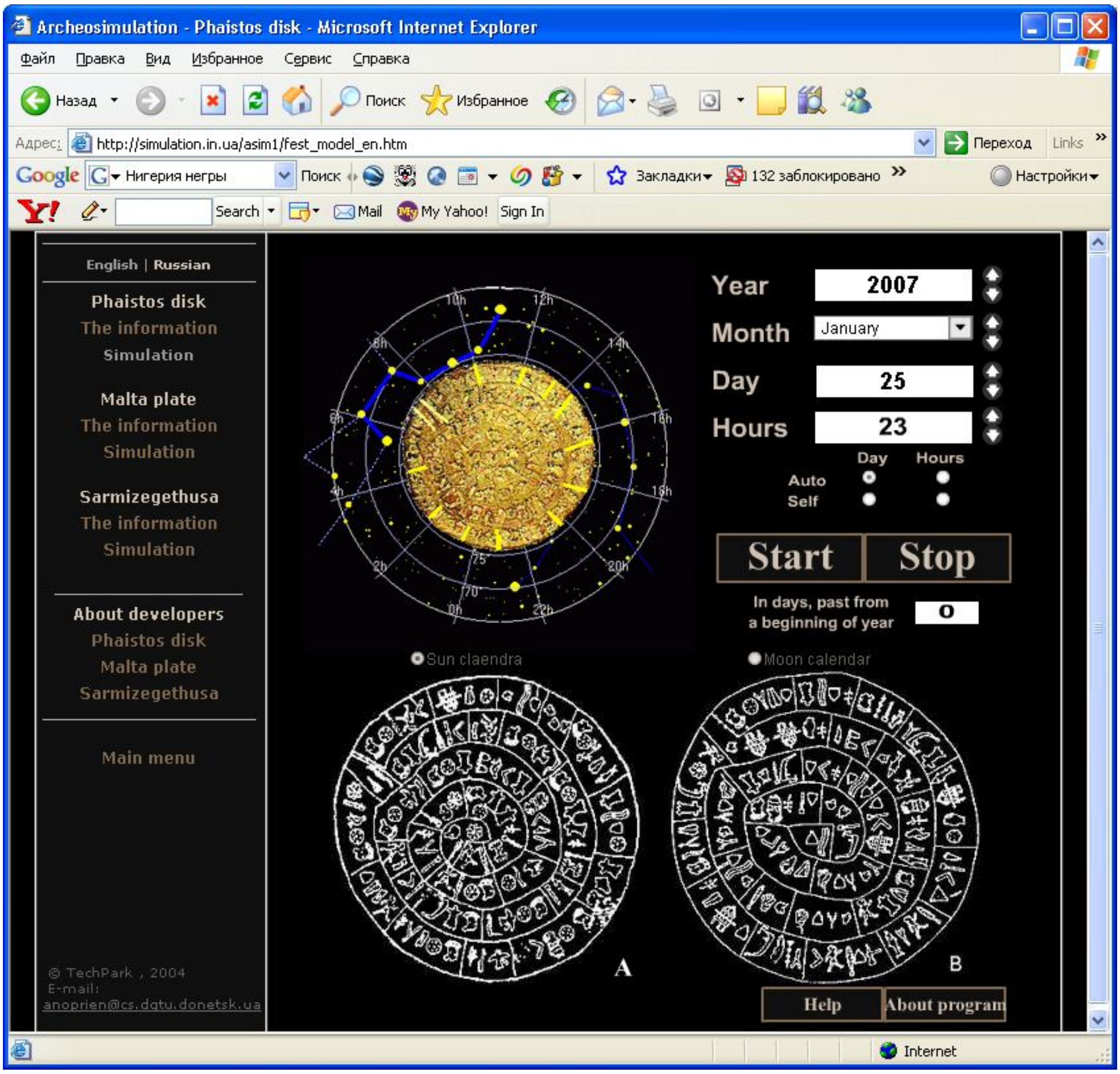

Figure 2. Simulation of Phaistos disk on on “Archeosimulation’s portal”

People have tried for decades to try and unravel the mystery of the Phasitos Disc but this has proved to be impossible for several reasons. There are very few examples of this sort of hieroglyphic script on Crete and since it never appears with any comparable text, there just are not enough examples for cross-referencing. Also there is no knowledge of the language spoken on Crete in Minoan times.

Each side of the Phaistos Disc contains an incised spiral. Within the whorls of these spirals are groups of hieroglyphs, pressed into the clay with pre-made tools. The groups are separated by incised lines crossing the spiral and there are anything between 2 and 8 glyphs per group. Side A of the Disc contains

123 glyphs within 31 groups, whilst side B has 119 glyphs within 30 groups. Many of the glyphs are repeated, some on both side A and side B of the Disc.

The Phaistos Disc and its groups of hieroglyphics was nothing more or less than a second calendar. This ran on periods of 123 days and was designed to allow the ritual year of 366 days to be corrected. Such a move is very important to any farming culture, so that planting and harvesting dates do not slip backwards of forwards throughout the year.

For both simulation artifacts we have now modern simulations tools which was developed in DonNTU (Ukraine) and now presented on "Archeosimulation's portal" :
http://sim.donntu.edu.ua/asim2/index_en.htm.
Such artifacts we can probably find in future also in Africa.

2 STATE-OF-THE-ART OF SIMULATION FOR MOBILE USERS

We can use now for simulation in mobile computers many various tools: Matlab/Simulink, GPSS, Excel, special tools for Computer Networks simulation (NetCracker and NS2 for example) and so on [5-8]. Most universal for mobile user now are various Java-tools. On the base of Java-platform we can develop simulation tool in wide range of applications: from mobile phones with J2ME to the global distributed environment with J2EE. Java-model for "Malta plate" was also developed in DonNTU.

A variant of expansion of classical binary logic and binary notation was proposed for simulation of all arts simulation tools from past, now and future: it is so called extended code-logical basis, which allow essentially increase information capacity and efficiency for description of dynamic processes and structures [9-10].

The majority of known modifications of binary and multivalued logic are in essence one-dimensional: the logic values 0 ("false", "no") and 1 ("true", "yes") are set on one axis, and all logic operations are carried out within the limits of this axis. But the variety of human knowledge is such, that the surrounding world can not be always unequivocally described by such a simplified scheme. Mainly because, there are at least two situations, which play an important part in the system of human knowledge: "Don't know" and "Know so much, that cannot answer definitely" [1]. An orthogonal arrangement of "False" and "True" axes permits to include the indicated situations in the formal logic system (Fig. 1). In such two-dimensional logic plane various systems of computer logic can be constructed.

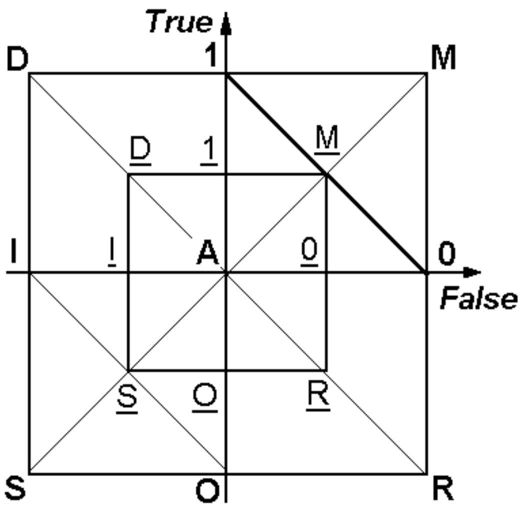

Figure 3. 2D logical space

The point A of absolute uncertainty is considered as origin of coordinates.
The points 1 and 0 are traditional logic significance's "true" and "false".
M can be interpreted as "multivalue" or "true and false".
$\underline{M}$ can be interpreted as "equiprobability of true and false".
S - "symmetry" of M.
I and O - "symmetry" of 1 and 0 respectivly.
D and R - two others variants of the "multivalue".

Various logical systems in this space we can specify as $L_N^K = \{x_1, x_2, ..., x_K\}$ with K= 1, 2, 3, 4, ... , where K is an order of the logic; x_1,

x_2, ..., x_K are various logical values from the 2D logical space; N - number of logic order K.

The variants of logic systems with four conditions present the heaviest theoretical and practical interest. Such systems can be named as "tetralogic". The tetralogic can for example include except two traditional logic significance's "true" and "false" also two additional significance's:
$L_1^4 = \{1, 0, A, M\}$ (it was proposed in [1]), $L_2^4 = \{1, 0, \underline{M}, M\}$,
$L_3^4 = \{1, 0, S, M\}$, $L_4^4 = \{1, 0, A, \underline{M}\}$.

The introduction of the suggested logic conditions allows to essentially expand the opportunities of classical binary logic and to adapt it for features of human thinking.

3 THE ARCHITECTURE OF THE FUTURE DISTRIBUTED ENVIRONMENT

Intensive development of the Internet infrastructure and modern communications creates conditions for effective realization of various web-based simulation services. In our days there are two common ways of development such simulation services. In the first case the system is developing from scratch, so it means that all the modern technologies can be used to gain better results. Of course it requires more time and efforts to development. Well known web-based simulation system built from scratch are: DEVSJAVA, JSIM, AnyLogic. The other way is to use existent (legacy) simulation system to build fully functional web-based simulation environment. It means that we get all the benefits from the legacy system without necessity to develop it. The examples of such system are: NetSim, WSE, WebDIVA. Integration of simulation services into uniform simulation environments is the most perspective variant of their development. The architecture of such environment and its basic components are considered in the given article. The suggested architecture is generalization of long-term experience of models and environments that have been developed for simulation of complex dynamic systems [10-12]. One of the main goals of such system is to improve educational process [13]. Another one is development of new web-based services on the basis of traditional simulation systems for the complex systems researching [14, 15].

Figure 4 shows the future architecture of the Distributed Environment for Simulation Services Integration (DESSI) in most general view [16]. Basic elements of environment are:

Web-based Clients (WBC) realize the universal and specialized mobile user's interfaces for access to the integrated simulation environment. The basic technologies for realization of WBC are Java web-start clients, Java applets (for "normal" clients) and JavaScript/Flash/HTML for the so-called "lite" clients.

Simulation Services Provider (SSP) is the main "entrance points" for all remote queries from WBC. Basic function of SSP is keeping and granting the information about simulation services for WBC. Client can choose necessary service from the list of offered and initiate the beginning of simulation session.

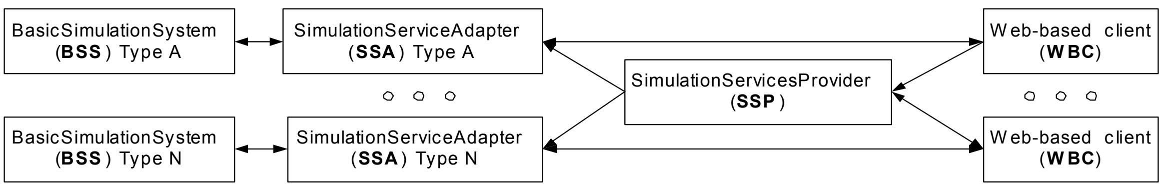

Figure 4. The overall view of the DESSI architecture

Simulation Service Adapter (SSA) is intended for communication with the base simulation systems. Every BSS normally has his own SSA. Basic function of SSA is providing the universal and transparent for the client access to the specific interfaces of various BSS. So the main role of SSA is implementing specific for each simulation system the mechanism of initialization, models loading, getting simulations results and so on.

The main benefits of such organizations are that for the all basic simulations systems (that were initially built using various languages and technologies) all clients have universal way to access simulations services.

Basic Simulation Environment (BSE) (что такое BSE?) / Basic Simulation System (BSS) - are the main server components of the DESSI.

The UML-diagram of interaction between base modules is shown in figure 5.

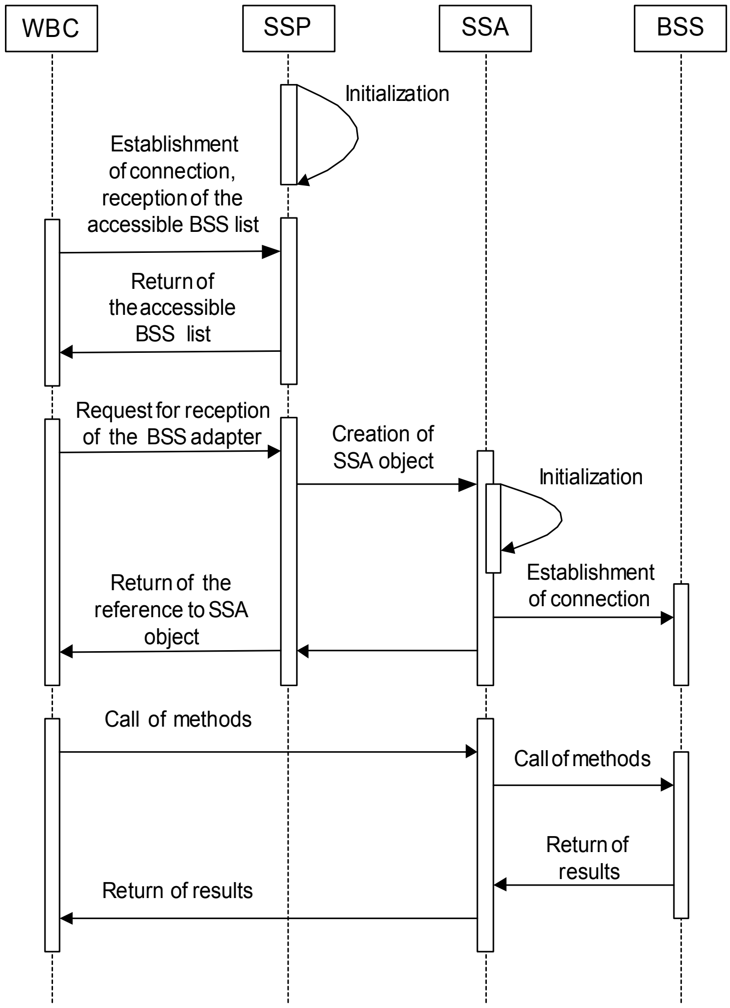

Figure 5. UML diagram of interaction between base modules of the DESSI

To start the simulation session WBC client connects to the SSP provider. Based on the information received (for example, from descriptions in special XML file) SSP offers WBC accessible simulation services (Simulation Services, SS). Then user, according to his current tasks, chooses the most appropriate SS for him to make his work. Provider SSP creates a copy of SSA adapter and returns the reference to it to WBC. All further communications continue between WBC and SSA directly.

Simulation Service Factory (SSF). For the adapter (SSA) functioning, it is necessary to have stable and effective connection with a running copy of the base simulation environment, for example DIVA. For reception (and also clearing at the end of a session) this copy is meaningful to take advantage of pattern Factory. The basic idea is that Factory incurs all the operations connected to initialization and running a copy of the simulation environment, and also - covers the organization of objects pool that can give an essential gain in productivity (fig. 6).

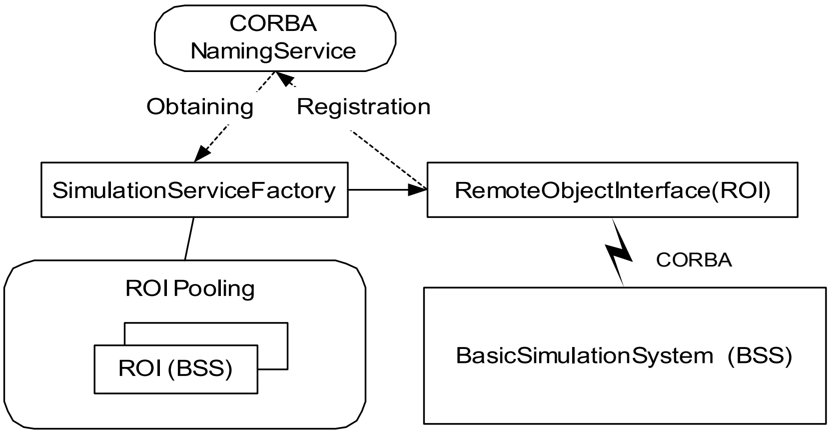

Figure 6. The organizations of objects "factory" for access to the simulation environment

Common Object Request Broker Architecture (CORBA) is used for making communications with the BSS. It allows transparent inter-communications in object oriented way between systems with various architecture types. A pool factory is formed from the remote object interfaces (RemoteObjectInterface, ROI).

The factory of object (SSF) is a special demon that works constantly during all life cycle of the system. The SSF does initialization and launching of several BSS copies and forms a pool of ROI objects in operative memory. The special XML-file is used to obtain the necessary details to do it.

Registration of ROI objects in CORBA naming service (CORBA NamingService) is necessary for further finding them by SSF (fig. 6).

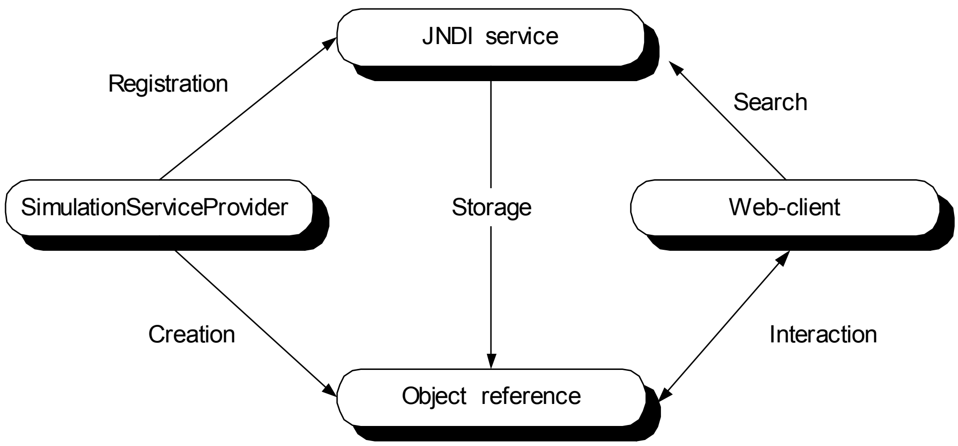

Figure 7. The mechanism of registration and search in JNDI service

The first and main point of entrance for the remote clients to the DESSI is SimulationServicesProvider. It has theoretically infinite life cycle for processed client's requests. Traditionally, the server's demons implementation in "client-server" architecture is done by row TCP/IP sockets programming. It requires low-level and based on TCP protocol programming that for complex systems is not optimal.

Technology J2EE, namely specification JNDI, gives more flexible model for registration and search for the objects in the distributed systems (fig. 7). The client is able to search for simulation services, using the information based only on a name of service, thus the knowing the physical IP addresses of servers and numbers of TCP ports aren't necessary. During primary initialization SSP module registers itself in the JNDI service under name well-known for all DESSI clients. So it means that client will be allowed to receive the object references of SSP for the further interaction.

The main goal of DESSI is granting access for web-clients to the server-side simulation systems. The expansion of such systems will be the major and most a challenge in the next future. We already have good experience in development remote access and interaction with simulation system DIVA. Now we are in a process of development the similar interaction with system Matlab/Simulink and others.

Figure 8 show the full model of the DESSI including all modules considered above.

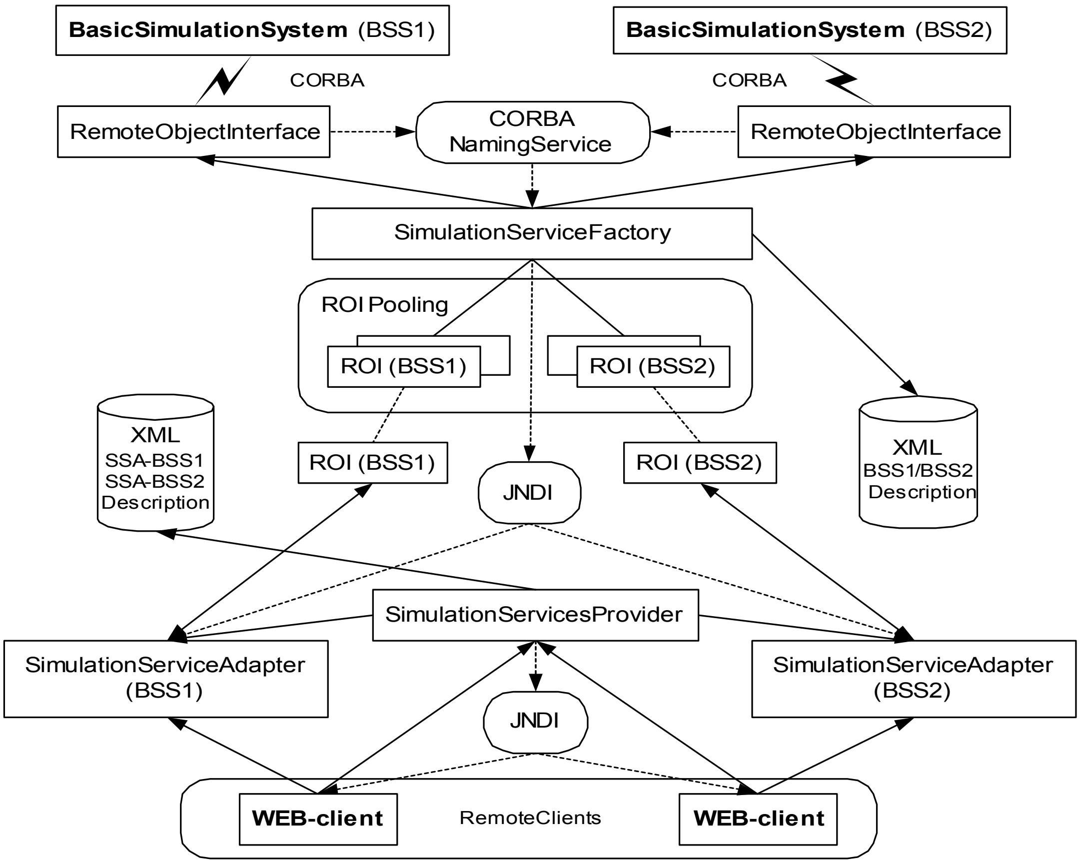

Figure 8. Structure of interaction between basic modules of DEISS (Example for 2 BSS)

The suggested architecture for now is a basis for program realization of the universal open WEB-based simulation environment with mobile client users. At first stage DESSI will give an opportunity for work with only complete models of various BSS. Supporting all development cycles of models by BSE/BSS full control is planned as the further development of DESSI.

REFERENCES

1. Anoprienko A. Interpretation of some artefacts as special simulation tools and environments / “Short Papers Proceedings of the 1997 European Simulation Multiconference ESM'97. Istanbul, June 1-4, 1997" - Istanbul, SCS, 1997, p. 23-26.
2. Anoprienko A. Archaeosimulation: new sight on ancient society and lessons for computer era / Problems of Simulation and Computer Aided Design of Dynamic Systems. Scientific Papers of Donetsk State Technical University. Vol. 29. – Sevastopol: Weber, 2001. P. 320-326.
3. Anoprijenko A. The early history of simulation in Europe: scale planetariums and astromorphic models // EUROSIM 2004: 5th EUROSIM Congress on Modeling and Simulation. 06–10 September 2004. ESIEE Paris, Marne la Vallée, France. Book of abstracts. S. 146-147.
4. Butler, A. The Bronze Age Computer Disc // Foulsham & Co Ltd, March 1999
5. Waschler R., Kienle A., Anoprienko A., and Osipova T. Dynamic plantwide modelling, flowsheet simulation and nonlinear analysis of an industrial production plant // In J. Grievink and J. van Schijndel, editors, European Symposium on Computer Aided Process Engineering - 12 - ESCAPE-12, 26–29 May, 2002, The Hague, The Netherlands, Amsterdam: Elsevier, 2002, pages 583–588.
6. Waschler R., Kienle A., Sviatnyi S., Gilles E.D., Anoprienko A., Osipova T. Modeling and Simulation of a Chemical Reactor for the Production of Acetic Acid - III. Dynamic Phase Transitions // Problems of Simulation and Computer Aided Design of Dynamic Systems. Collected Volume of Scientific Papers. Donetsk State Technical University. Donetsk, 1999. - P. 102-109.
7. Svjatnyi V., Feldmann L., Lapko V., Anoprienko A., Reuter A., Bräunl T., Zeitz M. Massive parallel simulation of dynamic systems // Zeszyty naukowe. - 1997. - №1. - P. 207-229.
8. Anoprienko A., Svjatnyi V., Reuter A., Zeitz M. Simulation Systems on The Basis of a Parallel Computer / 8th European Simulation Symposium 1996 ESS'96, Genoa Italy, October 24th - 26th, 1996.
9. Anoprienko A. Tetralogic and tetracodes: an effective method for information coding // 15th IMACS World Congress on Scientific Computation, Modelling and Applied Mathematics. Berlin, August 24-29, 1997. Vol. 4. Artificial Intelligence and Computer Science. - Berlin: Wissenschaft und Technik Verlag. - 1997. - P. 751-754.
10. Anoprienko A., Svjatnyi V., Reuter A. Extended logical and numerical basis for computer simulation / “Short Papers Proceedings of the 1997 European Simulation Multiconference ESM'97. Istanbul, June 1-4, 1997" - Istanbul, SCS, 1997, p.
11. Svjatnyi V., Feldmann L., Lapko V., Anoprienko A., Reuter A., Bräunl T., Zeitz M. (1997) Massive parallel simulation of dynamic systems. Zeszyty naukowe, №1, 207-229.
12. Anoprienko A., Bazhenov L., Bräunl T. (1997) The development of the interface subsystem for the massive parallel simulation environment. 11. Symposium in Dortmund “Simulationstechnik” (pp. 672-677), ASIM-97, Vieweg, Braunschweig.
13. Minaev A., Bashkov E., Anoprienko A., Kargin A., Teslia V, Babasyuk A. (2002) Development of Internet Infrastructure for Higher Education in Donetsk Region of the Ukraine. ICEE 2002 Manchester International Conference on Engineering Education, Manchester, U.K.
14. Anoprienko A., Potapenko V. (2003) Web-basierte Simulationsumgebung mit DIVA-Serverkomponente für komplexe verfahrenstechnische Produktionsanlagen. 17. Symposium “Simulationstechnik” (pp. 205-208), ASIM 2003, Magdeburg.
15. Waschler R., Kienle A., Anoprienko A., and Osipova T. Dynamic plantwide modelling, flowsheet simulation and nonlinear analysis of an industrial production plant // In J. Grievink and J. van Schijndel, editors, European Symposium on Computer Aided Process

Engineering - 12 - ESCAPE-12, 26–29 May, 2002, The Hague, The Netherlands, Amsterdam: Elsevier, 2002, pages 583–588.

16. Svjatnyj V., Anoprijenko A., Potapenko V., Zabrovsky S. The universal WEB-based distributed environment for simulation services integration // EUROSIM 2004: 5th EUROSIM Congress on Modeling and Simulation. 06–10 September 2004. ESIEE Paris, Marne la Vallée, France. Book of abstracts. S. 63-64.

How to Cite this Article:

Anoprijenko A., John S., Al-Ababneh H. Simulation Tools and Services for Mobile Users: History, State-of-the-art and Future // Proceedings of the International Conference & Workshop on 3G GSM & Mobile Computing: An Emerging Growth Engine for National Development, 29-31 January, 2007. – College of Science and Technology, Covenant University, Canaan Land, Ota, Nigeria. 2007. P. 9-20.