GUIDELINES FOR APPLICATION SERVICE PROVIDING IN THE AREA OF WEB-BASED SIMULATION AND OPTIMIZATION

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ABSTRACT

This paper considers advantages and actual problems of web based simulation systems. The concept of "Application Service Providing (ASP)" should be understood as a new business model for web based simulation environments. The paper presents a real Simulation ASP. The system is based on a database for all model and simulation data. Different simulation tools are permanently linked to the ASP control system and provide a continuos data flow to the end-user. The paper shows practical solutions for data security and reliability of external ASP-systems. A first draft of some guidelines for ASP-systems is provided at the end of this paper.

INTRODUCTION

The main architectures of web based simulations have been shown and tested successfully during the last years (Fishwick et al.1998, Healy and Kilgore 1997). The number of real applications and efficient tools for web based simulation is still very small. A critical analysis of web based simulation environments was made in (Kuljis and Paul 2000). After a review of actual web based simulation technologies, main problems are identified:

- A lot of web based simulation projects were done as a test scenario. The requirements of real customers were not taken into account.
- Often the terminus "web based" was understood only as a synonym for the ease of use, simple user interfaces and high flexibility. This is a fatal misunderstanding, because the web does not automatically solve all the old problems of simulation technology.

In conclusion, the further development of web based simulation should depend on a more user oriented approach and on a solution of old restrictions and problems of simulation technology. Only if real customers will see real advantages in speed, cost and flexibility, web based simulation will find a valuable position in future business information systems.
Instead the question "How can we transfer existing simulation systems to web ?" we should answer the question : "What are efficient web based simulation services for real customers at the actual time ?"

USER BENEFITS OF WEB BASED SIMULATION

Nearly all different requirements of simulation users can be transformed into basic terms of **profit** and **time**.
The profit is calculated as the difference between development costs of a simulation study and the expected revenues from the study. Development costs are influenced by the cost of the simulation environment and the modeling philosophy and comfort. Unfortunately the starting investments are on a high level between 5000$ and 50.000$ for typical simulation environments or external consultants. The revenue of a simulation study is unknown in the beginning. The risk of loosing money rises with increasing investment costs. Web based information technologies allow new business models of using simulation services. Instead of a high starting investment in software, simulation services can be rent for a interval of time.

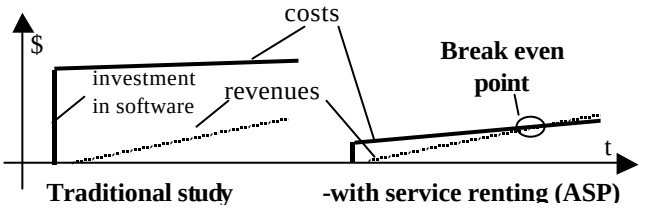

Figure 1: Costs of traditional and ASP-simulation

In traditional studies it takes a long time to reach the break even point. If the software is rented as a service, the starting investment is very small and equals the efforts for setting up the data interfaces (see figure 1).
The second term "Time" is important in real decision scenarios. Often a decision must be made under special circumstances like disturbance or external, unpredictable factors. The **"time to decision**", this means the time for finding a solution, is limited to some minutes or hours. This requires a very powerful simulation environment in terms of performance and optimization capabilities. More than one license and computer could be necessary. After the decision process is done, this environment runs idle until the next decision occurs. By using modern web technologies such free simulation capabilities can be used by other decision makers. The costs for simulation studies can be reduced significantly, if the peaks of required simulation power are averaged by a common pool of simulation resources, which are shared between different customers.

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"Portability" and **"interoperability"** are often called the most important benefits of web based simulation. This is particularly correct for the current state of different computer environments. Depending on the existing hardware there are only two options - the simulation study is impossible due to incompatible technologies or the systems allow data exchange and control. For the customer, portability plays the role of a "killer" question. If this question is answered positively, costs and time for decision making again become the most important benefits of web based simulation for the customer.

SIMULATION AREAS WITH HIGH EFFICIENCY OF WEB BASED SYSTEMS

The costs of developing complex simulation models are always very high. Although model generators and highly sophisticated modeling techniques could be used, the efforts for basic system research, data acquisition, model verification and validation actually are still connected with human resources. As it was mentioned before, the web supports operations with information distributing characteristics very well. Tasks with a high degree of creative work, resulting in synthesis of new web objects are still executed with external programs like HTML-editors or layout programs. This means - the internal structure and available functions of the current web are not ready for a real creative developing process ! This implies the following conclusions:

- The web can not simplify the modeling process in the near future. Simulation models should be developed by using traditional simulation tools.
- The web can support the reuse of existing simulation models very well by its distributed nature and the content management functions like search machines and common data access protocols.

If we combine these conclusions, web based simulation systems will be of high efficiency, if the models remain nearly unchanged and only the simulation control variables and the input data are changed. Models of this kind are based on real systems with a fixed structure and dynamic working conditions, like

- flexible manufacturing cells with N machines from a set of M machine types, where the load is defined by external ERM systems,
- computer network systems with static network layout and dynamic routing strategies and random loads,
- fixed railway networks with changing time tables,
- nearly all serving processes with fixed stations and changing customer requirements.

In traditional simulation analysis such systems are modeled as "black box" models and the load is defined by parameters or in various data files. Even GPSS was used 30 years ago for defining such models. The power of this approach is determined by the quality and flexibility of the implemented interfaces for data exchange.

REQUIREMENTS FOR SUCCESSFUL SIMULATION IN THE WEB

Repositories of Plug & Play models

Concerning the actual deficits of tools for development of web based user interfaces, the efforts for model design and test should be minimized at the current time. The idea of Plug & play from computer hardware architectures will work also in web based simulation. One possible solution is a three level model repository and handling system:

- The first level provides very common, fixed models. Only external data files will change the behaviour of the models. The models are defined in the language of the used simulation system.
- The second level provides a library of predefined components. The client can define specific parameters of the components.
  This method is similar to well known component based systems like Arena or TAYLOR. Only the user interface and the number of forms and parameters are simplified.
- The third level allows a free definition of source code for the used simulation systems. The service of the ASP-system is limited to the execution and result analysis of the simulation.

Automatic data exchange

In current web based simulation environments data exchange is often reduced to manual operations, like copying text into the source code of the model or extracting results from long trace lists. Compared to professional methods of data handling in data bases or data warehouses, this level of data exchange is not acceptable for professional customers. A efficient usage of web based simulation system requires a full integration in the common data flow of the enterprise. This integration can be made by time scheduled export and import routines in ERP-systems and the simulation environment. The FTP protocol can be used for the physical transport of the data files (see figure 2). Other protocols like HLA or CORBA are also possible, but require more development efforts.

Result analysis with database functions

If the client is provided with a ERP, Data Mining or decision support system, result analysis of simulation runs is possible by importing the simulation trace files and using the integrated functions of these systems. Clients without powerful analysis tools depend on the functions provided by the web based simulation system. As demonstrated by the VisualSLX system (Wiedemann 2000) (Wiedemann 1998), this task can be solved by using databases for storing the results and calculating all aggregated values. The actual power of client-server databases also supports multi-model and multi-run comparisons. Visualization of graphical diagrams is supported by small Java applets.

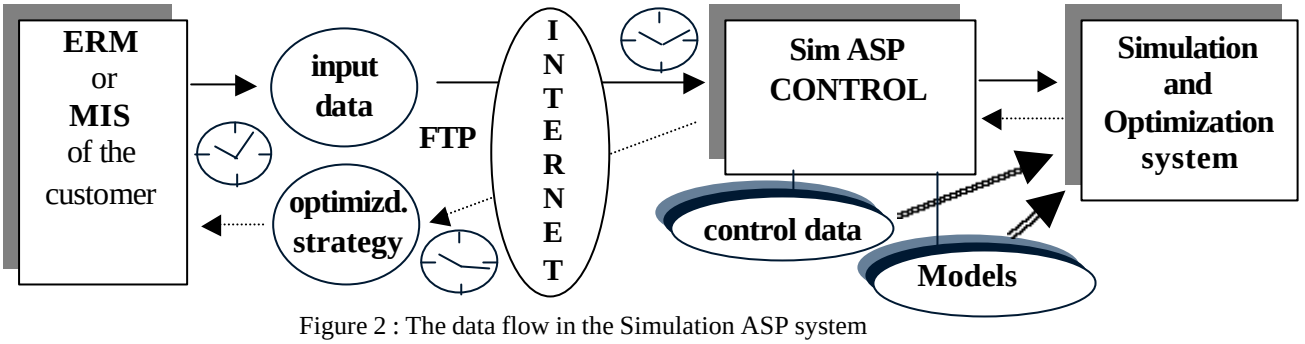

Figure 2 : The data flow in the Simulation ASP system

Fast and permanent access to simulation control functions

The first web based systems were often realized with CGI programs. The main disadvantages of this approach are low performance and a non-permanent connection to the simulation system. In result of the used batch mode, it was very difficult to control or interrupt a running simulation from outside. Information about the progress of the simulation was also hard to catch by CGI interfaces.
A web based simulation environment should provide a permanent connection between the client and the simulation kernel. State information and control functions must be available during the whole time of a simulation run.

A SIMULATION ASP-SYSTEM

Concerning the discussed requirements, an Application Service Providing (ASP) System for simulation was developed. Basic elements of this system are:

- a database for all model and simulation data,
- an object oriented modeling philosophy based on model entities and attributes,
- an universal code generator for converting the model description into a simulation program.

Details of the modeling philosophy and the code generator are presented in (Wiedemann 2000). The most important feature is the interface of the simulation environment to the web. In result of existing powerful software components for internet applications this interface is realized as combination of a Tool-Manager database system and a web-server-component (see fig. 3). Here we have no CGI-interface or similar technology. Database related requests from the web are received by the Winsock-component in the database- application and are answered immediately. Advantages of this web-server integration are:

- a very high performance in result of direct data-exchange and always open database tables,
- a long-time connection between the client and the server with continuous data flow during simulation or result processing.

Actually the SLX simulation system is used as a simulation kernel. For all code templates are stored in the database, the same code generator is used for HTML files and simulation programs.
The system can work in three modes:

- as a traditional, local stand-alone system,
- as a multi-user database in a local network,
- and as a real client server system in Intranet or Internet environments.

The first two modes are realized by traditional database forms. Application specific forms can be developed in some minutes by using latest technologies of assistant supported database design (e.g. in Microsoft Access).

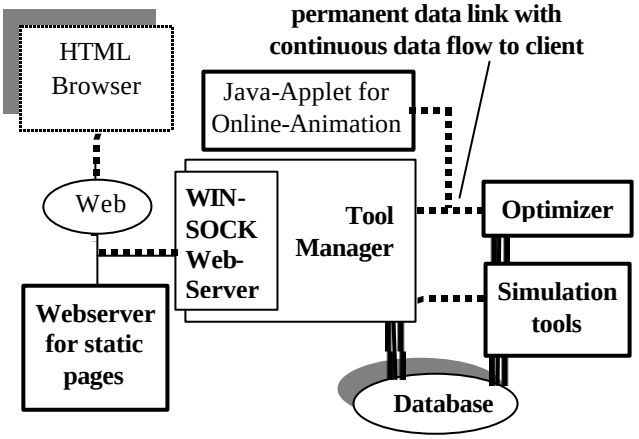

Figure 3 : The architecture of the system

Other supported simulation systems are SLX and Taylor. The optimization tool ISSOP can be used for larger experiments and automated improvements of the model parameters (Krug 1997). Other systems can be integrated without large efforts by a common template engine for transferring the task parameter to the application.
During the simulation or optimization process a XML-file with animation commands is generated. This file is interpreted by an Java-Applet at the Client side. In the future, this self-developed applet will be replaced by a similar, SVG-based animation system.

LICENSE AND SECURITY CONSTRAINTS

Web-based simulation also creates new requirements for software licensing and project management. Traditional software licenses of simulation packages only allow a single place usage. A web-based system must have the same license model like a network license. The payment of the simulation customers can be done per project or time. Another very critical fact is also data security. If a company uses a web-based simulation system possibly sensible data will be stored in an external database. A first level of security is possible by using standard Virtual Private network technologies. This improves the security of the data transport.

A further improvement of security is possible **by a content scrambling** at the side of the customer. Sensitive data like customer names or product brands are replaced by random values. The conversion table is stored only at the customers computer. For the simulator there is no difference about working on a order from BMW or on data of F3234. After the simulation is finished, the results are decoded by using the stored conversion table at the customer side. Even if the network connection or the simulator is hacked by external intruders, there is no risk of loosing information , because all important data does not leave the customer system.

All security issues should be seen as very important decision factors for or against a ASP-system. If a potential customer only feels some possible security risk of giving his data in external hands, this could be a "killer fact" against the ASP-idea, where all technical and financial benefits will be without any relevance.

Beside the technical security customers want also a high degree of reliability and flexibility of the ASP-system. It is very critical for a customer, if an external service provider is not full available at request time or the service is switched off. In difference to a installed system there is no chance of using an unsupported system some time until a new system is installed.

Since only one service provider is always critical for a customer, the best solution would be a network of similar ASP-servers. If one server is out of order other servers could provide the service or can backup data and results.

GUIDELINES FOR ASP-SYSTEMS

The main problem of building a network of ASP-servers is the standardization or at least definition of common interfaces. During the last 10 years this standardization was not reached in the area of simulation systems and models. It is nearly unpossible to exchange models between different simulation systems.

In the area of web-based system there is some hope for such a common definition. The network interface of ASP-systems allows a intermediate level between the simulation and optimization tools and the customer side information systems. This intermediate level should provide a standardized interface at the side of the customer. At the side of the real ASP-server the request will be transformed in tool-specific commands. First discussions with other ASP-developers show some real interest in such a definition. A first draft of a ASP-interface guideline include the following levels of standardization::

- **Level 1 – Identical Internet base technologies** like Apache Webserver und Java Servlets in a Tomcat-Servlet–Container with stable software version (no Beta-versions)
- **Level 2 – Standardization of Control- and Management interfaces,** like XML-code sequences for controlling of all calculation processes;
- **Level 3 – Common data structures for exchange of model input data**, like XML-based data exchange and databases with JDBC-interfaces;
- **Level 4 – Identical simulation and optimization tools, like** SLX/Arena and ISSOP.

In the actual moment nearly all ASP-systems are based on the internet base technologies from level 1. So this level already exist as some common start point.

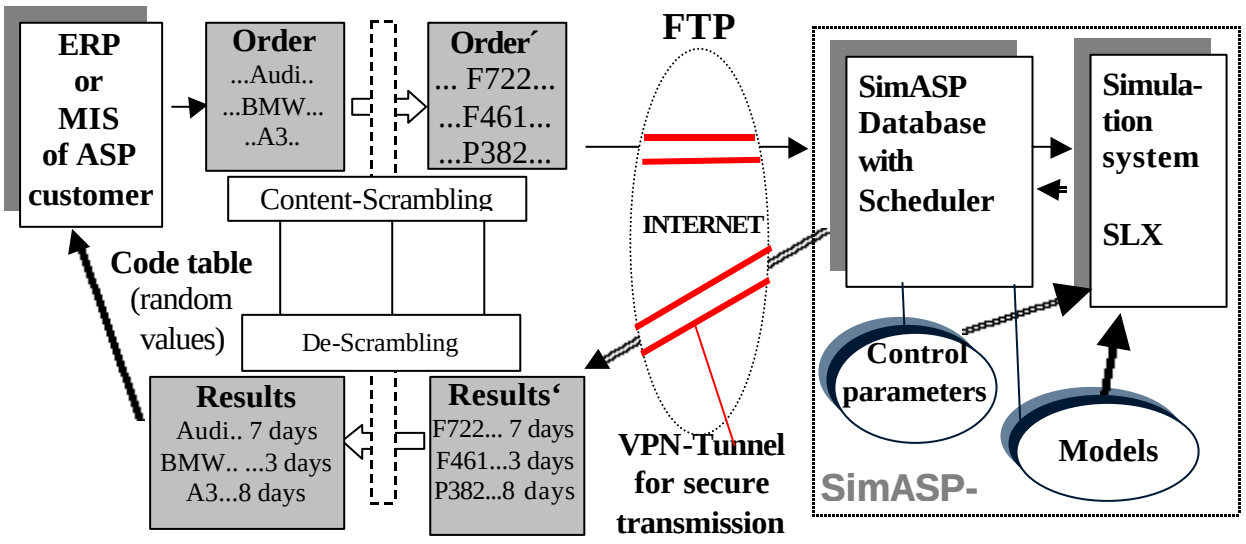

Figure 4 : A content scrambling system for secure exchange of ASP-data

If two ASP-systems are based on the same base software on Java-servlets, a backup copy of the servers could be done by simply copying the scripts and calculation tools. After this procedure only models and data must be exchanged for new customers.
The process of defining common ASP-interface guidelines and possible future standards is still in progress. Each interested developer, simulation expert or developer is invited in joined the workgroup (WWWASPGuidelines).

CONCLUSIONS

The perspectives of web based simulation will improve, if the current web technologies are used for a maximum of user friendliness instead of copying existing simulation systems to the web. Actually this approach will limit the capabilities of modeling large and complex systems. But the ease of use and the fast return of investments will turn this user driven approach into a very interesting way for improving and increasing the usage of simulation in commercial decision making.
The further development of this concept will enclose the following activities in the near future and are presented at (WWWSIMSOLUTION) :

- parallel and hyper-computing with a distributed version of the ASP-system.
- the transformation of the self developed Java-applet to a SVG-animation,
- graphical result analysis with database and data Mining tools via the web.

Important features of the developed system are:

- a flexible and open meta model for definition of application specific classes of simulation models;
- all model, meta model and simulation data are stored in databases;
- one code generator for the simulation source code and the HTML code for the web interface,
- flexible architectures for data-interchange with other, complex information systems,
- interfaces to software packages concerning statistical result analysis, presentation, optimization, Data-Mining and knowledge reasoning.

The main goal of this system is the execution of existing simulation models with different sets of data. The process of modeling is still realized by traditional. desktop tools and methods. With this system the user needs only common knowledge about modeling and simulation and no deep practice in the simulation language. This will enlarge the potential group of simulation users and firms.
The problems of data security is solved by an content scrambling system. The reliability of external ASP-systems is actual unsolved. One good solution would be a network of ASP-servers with common interfaces. The first draft of some guidelines for ASP-systems could be seen as a starting point for future ASP-networks.

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