

# Cloud Based Simulation Framework Optimal Engineering Design as a Service Ecosystem



Anatoly Petrenko\*

*Department of System Design, Institute for Applied System Analysis of NTUU, Ukraine*

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**\*Corresponding author:** Anatoly Petrenko, Department of System Design, Institute for Applied System Analysis of NTUU, Ukraine,  
Email: [tolja.petrenko@gmail.com](mailto:tolja.petrenko@gmail.com)

## Abstract

This paper provides a roadmap of development of the Engineering Design Environment, based on Service-oriented computing (SOC) and intended, in particular, for modeling and optimization of Nonlinear Dynamic Systems, based on components of different physical nature and being widely spread in different scientific and engineering fields.

**Keywords:** Service-oriented computing (SOC); Web-services, Cloud computing; Engineering design platform

## Introduction

A new approach to designing software architecture as a dynamic system of interactive, independent web services available through the network is emerging in the world today. This allows application developers to focus mainly on discovering and compositing services that meet business/technical characteristics, and to minimize the development of a new code. Software architecture is based on a knowledge base that contains ontology of subject areas.

The Engineering Design Framework supports end-users in developing customized simulation applications in the form of Software-as-a-Service (SaaS) based provision. Under Service-oriented computing concept (SOC) the entire simulation process is broken down into a set of loosely-coupled interacting cloud services (specific software components with unified interfaces) that can be performed at different Cloud sites and can be dynamically orchestrated to execute the simulation workflows composed by the users of the web-based environment. This original conception of Engineering SOC with Design procedures as web-services has no complete competitor worldwide.

## Technical Specification

- A. Implementation of the emerging distributed design paradigms in Engineering, which can be executed in cloud environments.
- B. Development of tools for solving interdisciplinary problems of Optimal Engineering Design with required accuracy in a reasonable time, supporting remote collective work. These tools enable users to build and adjust scenarios and workflows of their design procedures or mathematical

experiments via the Internet by selecting the necessary web-services (as computing procedures) to be executed on cloud resources, including automatic creation of equations of a mathematical model (an object or a process) based on a description of its structure and properties of the used components.

C. Creation of design web-services repository which contains components developed by different producers that support collective design work and globalization of R&D activities in Europe, either for free or with certain fee. These services include autonomous, platform-independent Design procedures of CAE/CAD tools: operations with large-scale mathematical models, steady state analysis, transient and frequency domain analysis, sensitivity and statistical analysis, parametric optimization and optimal tolerances assignment, solution centering, etc.), and supporting procedures (cloud hosting, domain ontologies transformation into code through Model-driven approach, data formats translation, etc.).

D. Development of a structure and component interfaces of the specialised Optimal Engineering Design software, based on the orchestration of web-services in service-oriented, distributed computational cloud infrastructure.

## Advantages

- A. Personalization and customization of Design in Engineering because users can build and adjust their design scenario and workflow by selecting the necessary web-services (as computing procedures) to be executed on cloud resources.

B. Implementation of unique novel numerical algorithms proposed for many design web-services (multi-criterion optimization, optimal tolerances assignment, yield maximization, stiff- and ill-conditional tasks solving, etc.).

C. Provision of best-practice for the development of Large Software Projects and flexible coexisted applications.

Although there are many other existing tools that can be useful in some selected cases for grid/cloud applications and sharing resources there is no single complex solution that sufficiently meets all of requirements with respect to Optimization and Simulation of Complex Non-Linear Engineering Systems in Cloud. Proposed approach, been based on service-oriented computing, is completely different from present attempts to migrate monolithic large CAE/CAD software systems into the cloud infrastructure as it is done in CloudSME Project (<http://www.cloudsme-apps.com/>).

### Stage of Development

The prototype of the service-oriented Engineering Design Framework was developed for Electronic Design Automation domain as the flexible networked simulation and modelling

tools for “bottom-up” or “top-down/bottom-up”. By changing the content of web-service repositories it is possible to expand the solution in hand on business process modelling, Mobile Medicine supporting, and interoperable E-governance applications designing. Innovations of the proposal are proved by abroad publications [1-3].

### Conclusion

Solution in hand is designed primarily to meet the needs of small and medium enterprises in the modern toolkit design of complex technical objects and technological processes, as well as the small research laboratories to perform complex computational experiments.

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