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# Composition of remote computation services of electromagnetic models: application to an electrical machine and its controller system design

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**Abstract**— With the increasingly high level of electromagnetic system integration, the system modeling, simulation and design are more and more challenging. The emerging domain of cloud computing can be useful to make system components models available anywhere as a computation service. This offers the possibility to only share the behaviour of every component when manufacturers want to hide sensitive information regarding their modeling knowledge. A web service standard, as well as a tool which generates it automatically from a model and deploys it on a web application server, are proposed. The design study of a system composed of a motor and its speed controller illustrate the approach.

## I. CONTEXT: CLOUD COMPUTING

Providing computing capabilities simulation and optimization available in remote webservers can have many advantages and benefits: Green computing (use of virtualized and shared computers) / Dependability (services and shared data are stored on reliable architecture) / Scalability and maintenance (a shared service can evolve without new deployment and local travel) / General availability of services unitarily expensive (computing licenses, forecasting, optimization with heavy calculations) / Innovation facilitated (assembly service generating new uses, emergence of new actors, users become service providers) / Unlimited storage and computing capacities (at least temporarily).

## II. FROM COMPUTER COMPONENTS TO WEB SERVICE

However, these benefits can not be achieved at the cost of a paradigm shift in the modelling, simulation and design currently used in industry. This requires going beyond the paradigm of modelling and simulation tools, i.e. beyond the software implemented in actual consulting firms to perform the design of an electromagnetic device that relies on non-distributed and non interoperable computing environments. So, the paper proposes a solution based on the concept of open framework, itself based on the concept of autonomous software component, which are capitalizable and dedicated to interoperability and reuse. The component approach extends the object oriented paradigms proposed in software architectures of computer science. It is within this framework that was developed ICAR<sup>1</sup> components. These software components can handle issues such as communication between software tools such as Flux<sup>TM</sup> FEM software and system simulation software using VHDL-AMS [1]. It can deals with the heterogeneity of programming language and operating system, model capitalization (i.e. models libraries), and then systems composition modelling.

We propose to remotely access to the software component

using web-services [2], built and deployed automatically.

## III. CASE STUDY

The case study is the design studies (time simulations and optimal sizings) of an induction motor drive. In figure 1, two models are available as web services in the “cloud”. Software components of each model (motor and speed controller) are supposed made available, by their manufacturer, to the integrator as “black boxes”. The integrator can use their web services to locally call models but each computation is made distantly. Depending on each model time consumption, it can be an advantage for global computation time, except for lightweight models as analytical models.

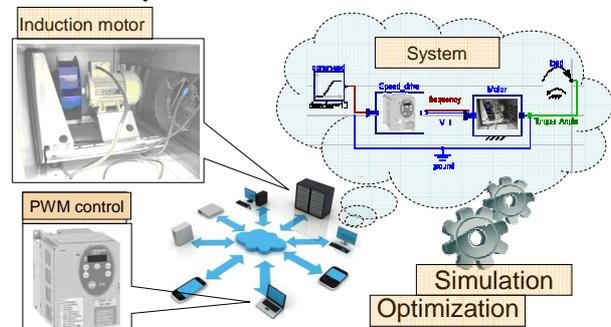


Fig. 1: Studied application

Figure 2 shows the results of the optimal voltage control law leading to the global efficiency minimization for each frequency.

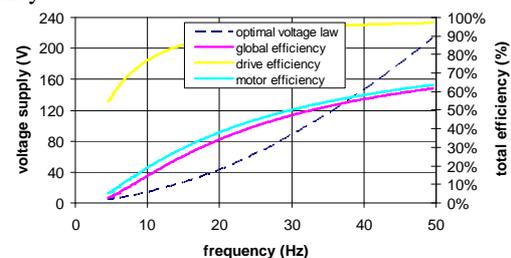


Fig. 2: Efficiency and voltage supply according to frequency

## IV. CONCLUSIONS

The paper proposes a software component standard used to deploy models as web services. A software tool has been made to make it available automatically based on semi-analytical models, but numerical models can be also supported.

## V. REFERENCES

- [1] Rezgui A., Gerbaud L., Delinchant B. “VHDL-AMS to Support DAE-PDE Coupling and Multilevel Modeling”, IEEE Transactions on Magnetics, Vol. 48, No. 2, Feb 2012
- [2] Tarricone L., Esposito A., Advances in Information Technologies for Electromagnetics, Springer-Verlag New York Inc. 2006

<sup>1</sup> ICAR : interface for component architecture