ISES

Intelligent Services for Energy-Efficient Design and Life Cycle Simulation

SEVENTH FRAMEWORK PROGRAMME

NEWSLETTER #5 **1 July 2014**

Univerza v Ljubljani

The University of Ljubljana, founded in 1919, is the largest university in Slovenia with over 50,000 students and more than 6,000 persons teaching and research personnel. In the ISES project it is represented by the Chair of Construction Informatics which has gained international reputation in the fields of semantic technology and cloud computing.

ISES is STREP project # 288819 funded by the EU under the 7th Framework Programme. The **objective** of the project is to develop ICT building blocks to integrate, complement and empower existing tools for design and operation management to a Virtual Energy Laboratory that will allow simulation, assessment and optimisation of the energy efficiency of built facilities and facility components in variations of real life scenarios before their realisation, acknowledging the stochastic nature of the involved information resources.

In this issue, we present the ISES platform ontology binding together the multiple distributed resources required for the efficient functioning of the ISES Virtual Energy Lab and the concepts regarding sensitivity analysis, visualisation and design decision making after multiple simulations have been run in parallel on a cloud environment.

The Cloud Environment of the ISES Virtual Energy Lab

An outstanding characteristic of the Virtual Energy Lab Platform (VEL) developed by ISES is the use of *cloud computing* for the solution of sophisticated energy related tasks involving the testing of different design alternatives, sensitivity simulations, parametric studies, use of stochastic input parameters for more accurate description of the examined physical processes, full building simulations and fluid dynamics analyses. The developed architecture and technical workflows of the VEL provide a clear and transparent possibility to the end user to prepare the needed model data locally, specify and run parallel heavy-duty computations on the cloud via the ISES Cloud API and, after suitable post-processing of the results based on well-defined energy Key Performance Indicators, examine the outcome on a multi-model navigator utilizing advanced visualization techniques. This enables reduced processing times by an order of magnitude and increased capabilities to try different (up to hundreds) design options, leading to better informed, holistic decision making. Without the use of cloud computing such capabilities would hardly be possible.

The ISES solution focuses on an open cloud environment that is affordable not only for large companies but to small and medium enterprises as well. The deployed hybrid cloud infrastructure is based on the *OpenStack* cloud environment (http://www.openstack.org). OpenStack is a collection of open source technology that provides scalable cloud computing software. It can be used by corporations, service providers, VARS, researchers, and global data centers looking to deploy large-scale solutions for private or public clouds. High-throughput computing is provided via the *HTCondor* software (http://research.cs.wisc.edu/htcondor/) which manages the queuing system for compute-intensive jobs. It provides traditional queuing and scheduling functionality, along with innovative technology, such as resource classifications.

The minimal cloud hardware environment is deliberately chosen to suit the requirements, scope and limitations of medium-sized consultancies. It currently includes 10 rack-mounted servers with:

- Intel Xeon Processor L5520 (2.26 GHz)
- 8MB shared L3 cache 8GB (2 x 4GB),
- Embedded SATA RAID 0, 1, 10
- HP 2 x 500GB 7.2k Hot Plug SATA
- 5 TB Fibre-Channel disk array

ISES cloud test-bed located at the University of Ljubljana

Cloud-enabled Simulation and Analysis Tools on the ISES Virtual Energy Lab

The ISES platform integrates a variety of energy simulation and analysis tools that are run on the cloud environment to leverage maximal performance and parallel execution of complex computational tasks.

NANDRAD (www.bauklimatik-dresden.de/nandrad/) is a solver kernel for multi-zone building energy performance simulation. It is designed to perform transient solutions to energy balances in thermal zones and discretized construction elements. It provides also thermal comfort evaluation (e.g. indoor air temperature, operative room temperature, temperature of the inner surface of envelope elements). The NANDRAD solver is applicable to buildings with a large number of spaces using optimized numerical algorithms. In ISES, NANDRAD is used for passive and full building thermal simulations.

THERAKLES (http://bauklimatik-dresden.de/therakles/index.html) is an energy simulation tool that calculates thermal transport processes in individual thermal zones in buildings. The simulation takes into account the effect of the outdoor climate, the usage characteristics, the particular features of the ventilation, cooling and heating as well as the influence of neighbouring zones. The lightweight engine is designed to calculate results very quickly. Due to that, in ISES Therakles is used to perform multiple parallel sensitivity simulations as precursor and background for informed energy-aware decision-making and selection of alternatives for further sophisticated full building simulations.

RIUSKA (http://www.granlund.fi/en/software/riuska/) is a versatile comfort and energy simulation application. It uses as input an IFC model to calculate the thermal conditions of a building and its spaces in different loading and weather conditions. Built upon the DOE-2 energy simulation engine, RIUSKA can be used to ensure compliance with the user requirements and objectives, comparison of architectural solutions (window protection, façade solutions etc.), analysis of problematic spaces, projected consumption of maintenance etc. In ISES it is used for early design studies where fast performance and versatility are more important than full modelling and computational accuracy.

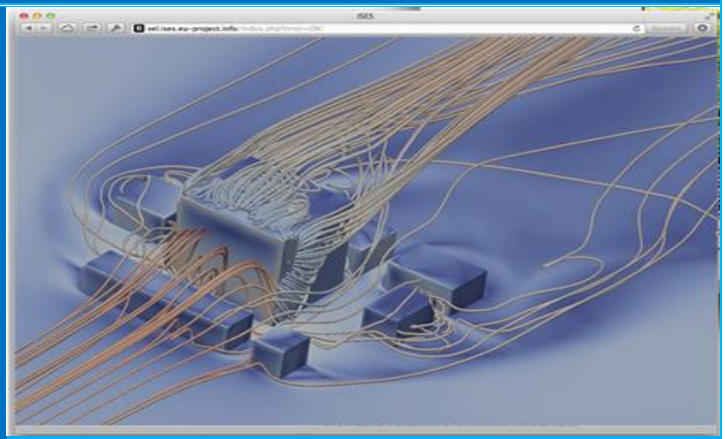
SARA is a computational fluid dynamics tool of SOFiSTiK (http://www.sofistik.com/en/) built upon the popular open source CFD Solver DOLFYN, which is a face-based implicit finite volume method software suite, employing primitive variables on 3D unstructured polyhedral meshes. Its features include standard k-ε and RNG turbulence models and it is known for its stable numerical procedures. SARA provides automatic mesh generation, various possibilities for the definition of complex boundary conditions, easy wind definition and sophisticated graphical presentation features.

Other tools running in the ISES cloud environment that are considered for further integration on the ISES VEL include the widely acknowledged energy simulation system EnergyPlus, visualisation tools (ParaView, VisIt) and scientific and other general engineering software such as MATLAB.

ISES CONSORTIUM

The ISES Consortium, enlarged in the second year, comprises four industry partners, three research organisations and three universities.

- TECHNISCHE UNIVERSITÄT DRESDEN, Germany (Coordinator)
- GRANLUND, Finland
- UNIVERZA V LJUBLJANI, Slovenia
- NYSKOPUNARMIDSTOD ISLANDS, Iceland
- SOFISTIK HELLAS, Greece
- NATIONAL OBSERVATORY OF ATHENS, Greece
- LEONHARDT ANDRÄ UND PARTNER, Germany
- TRIMO INZENIRING, Slovenia
- RUSSIAN ACADEMY OF SCIENCES, Russia
- UNIVERSITY OF CYPRUS, Cyprus



Result video obtained for the computation of wind influence on thermal behaviour for a test building performed with the CFD simulation tool SARA

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