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Bundesministerium
für Wirtschaft
und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages

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Research results of the Migrate! project

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Project summary

Project title: Migrate! - Models, methods and tools for migration to cloud-based energy-optimised user infrastructures and their management

BMWi code: 01 M1105 2 to 01M11058

Term: 01/10/2011 to 30/09/2014

Consortium: University of Hohenheim (FZID)

IBM Deutschland Research & Development GmbH

Drees & Sommer Advanced Building Technologies AG

Brandenburg IT service providers (ZIT-BB)

University of Stuttgart (IAAS)

Robert Bosch Gesellschaft für medizinische Forschung mbH

Stuttgart Airport

Project director: Dr. Jörg Leukel, University of Hohenheim

Website: www.migrate-it2green.de

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Research topics

The Migrate! project develops solutions for the transfer (migration) of existing local ICT applications (source systems) into integrated, cloud-based ICT user infrastructures (target systems) with the goal of holistic energy savings.

Core topics of research are:

- Development of a process-oriented migration model for applications, including an analysis of the source and target system
- Integration of socio-economic and environmental (green) requirements in the migration model
- Software solutions for automated modelling (TOSCA)
- Exemplary modelling for selected applications
- Determination of energy efficiency potential through cloud migration

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Automatic migration to the energy-efficient system

Starting situation:

- Currently, most ICT applications are manually migrated to the cloud
- This requires special knowledge, is labour-intensive and therefore expensive
- Energy efficiency is not addressed in this context in an integrated manner
- Therefore, a variety of tools must be configured individually and calibrated over the entire hardware and software range

The approach of MIGRATE!:

- The ICT application to be migrated is described in a standardized and extensible model using a software tool (TOSCA)
- A number of requirements are included in the model, such as energy-related performance indicators (green policies)
- If the target systems correspond to the specific requirements catalogue of an application, the application is automatically migrated to the cloud

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User systems analysis and modelling

In the project, key aspects of a process model for the migration of ICT applications from the areas of the hospital, airport, authority, and housing association were developed:

- Description and analysis of user systems of the source and target systems
- Energy-related measurement of performance data and simulation of system behaviour in the source and target system
- Integration of socio-economic and environmental aspects in the technical process of migration
- Consideration of legal constraints and user requirements – regarding data privacy, for example
- Creation of migration scenarios with the goal of saving energy
- Tools for planning, implementation and monitoring of the migration

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Open source tool “TOSCA”

The application to be migrated is described in the standardised and extensible TOSCA model:

- The Topology and Orchestration Specification for Cloud Applications (TOSCA) developed by the Advanced Opens Standards for Information Society (OASIS) serves as a software solution.
- TOSCA describes the topology and interaction of applications on the levels of operating system, middleware and application logic, including all necessary deployment steps
- The TOSCA template of the application is processed by what is known as the TOSCA container
- The TOSCA container directly controls the hypervisor cloud infrastructure to migrate the application

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Energetic control on the application level

Green policies were developed for the TOSCA model. This makes it possible to anchor energy optimisation as part of the requirements specification of the application-driven migration process:

- The cloud provider provides data that is retrieved from a local energy management system (EMS) and passed to the TOSCA container of cloud management
- Green policies are rules and thresholds that implement what are known as energy-saving plans
- The green policies are also monitored by the TOSCA container and the cloud infrastructure is affected through the hypervisor
- The open source version with energy policies is developed in Migrate!.

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Energy-optimised cloud systems

Testing of allocation methods:

- Auction-based models: conventional auction method with optimisation of the user-provider situation, with consideration of green aspects (such as PuE)
- Reservation price-based method: a process taken from the service sector in which energy optimisation is taken into account through booking classes.

Tools for energy optimisation:

- Winery: Graphical editor for TOSCA for creating application models
- GreenSLA: Inclusion of energy optimisation aspects in conventional SLA (Service Level Agreements)
- Energy management system: To enable tools for collecting and providing measured data from data centres for cloud management in order to enable optimisation

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Savings potential

Results of the simulations and field tests

- Airport: up to 50%
- Housing association: 25 to 54%
- Public IT service provider: 10 to 25% (simulation)
- Hospital: no simulation data available

Challenges:

- Difficulties in identification of suitable applications
- Migration costs that are often high, automation needs to get better
- In some cases, infrastructure measures (such as tablets as clients) are used

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Making use of the results

Cloud migration model:

- Integrated model published
- Application migration as a possible business area

Development of the TOSCA standard and corresponding products:

- Public and semi-public developments achieved in the project (OpenTOSCA, LEGO4TOSCA)
- The market for such standards and products is just getting started; competing approaches available

Energy monitoring and control / facility management:

- Making use of the insights gained into the consumption patterns of buildings through partners for design of energy concepts and planning of real estate projects
- Unclear market situation, as previously there were separate submarkets

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Patents, publications and standardisation

- No patent applications
- Publications:
  - 25 predominantly international publications in relevant conferences and journals
- Lectures including:
  - IEEE International Conference on Cloud Computing 2014, Anchorage
  - IEEE International Conference on Cloud Engineering 2013, San Francisco
  - Multikonferenz Wirtschaftsinformatik 2013, Leipzig
- Standardisation:
  - Contributions to TOSCA (Topology and Orchestration Specification for Cloud Application) of the OASIS
  - In particular, contributions on taking “green” policies into account