ITEA 4

Project Results

AutoDC

Enabling the datacentres of the future

The ITEA project AutoDC (Autonomous Datacentres for Long Term Deployment) has developed design choices and enabling technologies for autonomous edge datacentres. By focusing on autonomy, it serves as a foundation for datacentres which can operate without human intervention despite contextual interferences like power failure and overheating.

Edge computing is a double-edged sword: despite offering greater speed and security, it brings higher levels of operational complexity, thereby leading to rising costs and the need for better maintenance. Questions of sustainability and trained personnel will also play a role in the development of edge datacentres, which are expected to reach the market within five to ten years. As administration and maintenance already account for one third of operating expenses in datacentres (and are growing due to distributed edge nodes), greater autonomy is needed to make the eventual step to the edge.

As edge datacentres are still in the very early stages of development, AutoDC has carried out applied research into various aspects of hardware and software autonomy. This has been shown as the best means of saving money in the datacentre domain and will help get edge datacentres off to an efficient, cost-effective start. The project drew inspiration from radio base stations for telecoms, which utilise robust, automatic maintenance and thus rarely need to be visited for repairs. Overall, this means finding the sweet spot between over-design (i.e. many fans for a higher mean time before failure) and costs (more fans use more energy), ultimately allowing edge datacentres to be deployed to remote areas worldwide.

Technology applied

AutoDC's innovations are split between hardware and software, with the former focusing on the best design for autonomous datacentres. This mainly concerned container design, Uninterruptible Power Supply (UPS), power back-ups and server cooling, all of which need to minimise moving parts such as fans and pumps as these require the most frequent repairs. One key achievement is the combination of immersion cooling and passive heat rejection for greater energy efficiency, helping to determine the best design for autonomous edge nodes. Another important demonstrator shows how DC/AC power distribution monitoring can collect data from USPs, serving as the basis for an automated invoicing system by project partner Hi5.

Regarding software, AutoDC's primary outcome is a reference architecture for machine learning/reinforcement learning-enabled automation. Machine learning is crucial to turning collected data into information that can be used to detect faults, optimise the system and make recommendations to be dealt with automatically or passed to users via portals. A particular success has been transfer learning: when the system changes, the models which analyse nodes need to adapt and can do so more quickly through the transfer of applicable models from elsewhere in the system. This may also bring down the time taken to train new nodes from weeks to days. Finally, datacentre technologies are usually siloed with little communication between different areas, making cybersecurity more difficult as a whole; Clavister has therefore worked on integrating firewalls and network monitoring into the data collection to detect anomalies in network traffic that may indicate a breach.

Transport of an autonomous edge datacenter to a site for 5 years of zero-touch operation

Making the difference

AutoDC's results can be viewed in terms of domain expansion, new products and services and greater sustainability for the datacentre industry. At the heart of the project is the opportunity to make significant cost reductions on maintenance and operations. For the current datacentre market, a 1% decrease in capital expenditure is predicted to create EUR 540 million in market savings in 2022; it therefore stands to reason that greater autonomy

can achieve similar results in a future edge datacentre market. Despite focusing on datacentres, the project's results will also prove applicable in other areas that require increased speed and reliability, such as augmented reality, communication between autonomous vehicles and navigation in the mining industry.

For the consortium, AutoDC has led to the creation of 22 exploitable results, including eight patents on automating model management using transfer learning and feature selection. These will now be integrated into product development units within and outside of the datacentre domain. Ericsson has seen particular success with automated source selection for online learning (reducing resource allocation by around 10% compared to standard algorithms) and reinforcement learning for energy improvements in datacentres (demonstrating around 60% greater power usage efficiency compared to the world-class RISE ICE datacentre). AutoDC also involved a large number of SMEs, which have been able to improve their product lines and operations. kW-set, for instance, used the project to digitalise their paper-based system to improve maintenance.

AutoDC is now in a dissemination phase, having so far generated seven theses, 35 publications and 11 keynotes, presentations and workshops. ITEA has proven a fruitful medium for collaboration and the partners are already pursuing a new project investigating sustainability in edge nodes versus cloud nodes. In the longer term, it is thought that greater autonomy may result in 50% fewer CO2 emissions for datacentres (due to minimised site travel and construction) and the opportunity to introduce edge datacentres to developing countries, and AutoDC is an important stepping stone in making this future a reality.

Major project outcomes

Dissemination

- 35 publications and 11 presentations at conferences/fairs

Exploitation (so far)

Algorithms:

- Automated Source Selection for Online Learning (Ericsson)
- State discovery and prediction from multivariate sensor data (Aalto University)
- Reinforcement learning for energy improvements in data centers (Lund Univerity)
- Automated Source Selection for Online Learning (KTH)
- Privacy preserving of control algorithm (RISE)
- Predictive Supply Air Temp Optimisation (Mariner)
- Cost-responsive Supply Air Temp Optimisation (Mariner)

Software:

- Automated informative network security alerts engine (Clavister)
- Network device identification and inventory control (Clavister)
- Host and service Auto Discovery (ITRS)
- Autoscaling of monitoring resources (ITRS)
- Data collection for power usage (ITRS, Comsus, Hi5)
- Commercial product called Echidna (Hi5)
- Interface to RISE ICE's CFD model (RISE)
- Automated ML Data Pipeline (Mariner)

Hardware:

- Grid balancing using FFR, Fast Frequency Reserve (Comsys)
- Optimised Telco EDGE Cooling (Granlund)
- Passive Free Cooling Solution (Swegon)
- Microgrid DC with Mixed Energy Storage with complementary model (RISE)

Patents

8 patent applications filed, a.o.:

- Source Selection based on Diversity for Transfer Learning, Ericsson
- Policy Induced Feature Selection, Ericsson

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AutoDC

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Partners

Canada

- Ericsson
- Mariner Partners Inc
- Missing Link Technologies
- Saint Mary's University

Finland

- Aalto University
- Granlund Oy
- kW-set Oy
- Orbis Oy

Sweden

- 5 High Innovations AB
- Clavister
- Comsys AB
- Ericsson
- ITRS Group
- KTH Royal Institute of Technology
- Luleå University of Technology
- Lund University
- RISE - Research Institutes of Sweden
- Swedish Modules i Emtunga AB
- Swegon Operations AB

Project start

October 2018

Project end

October 2021

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