M²DC

MODULAR MICROSERVER **DATA CENTRE**

The New Class of Scalable Resource Efficient Appliances

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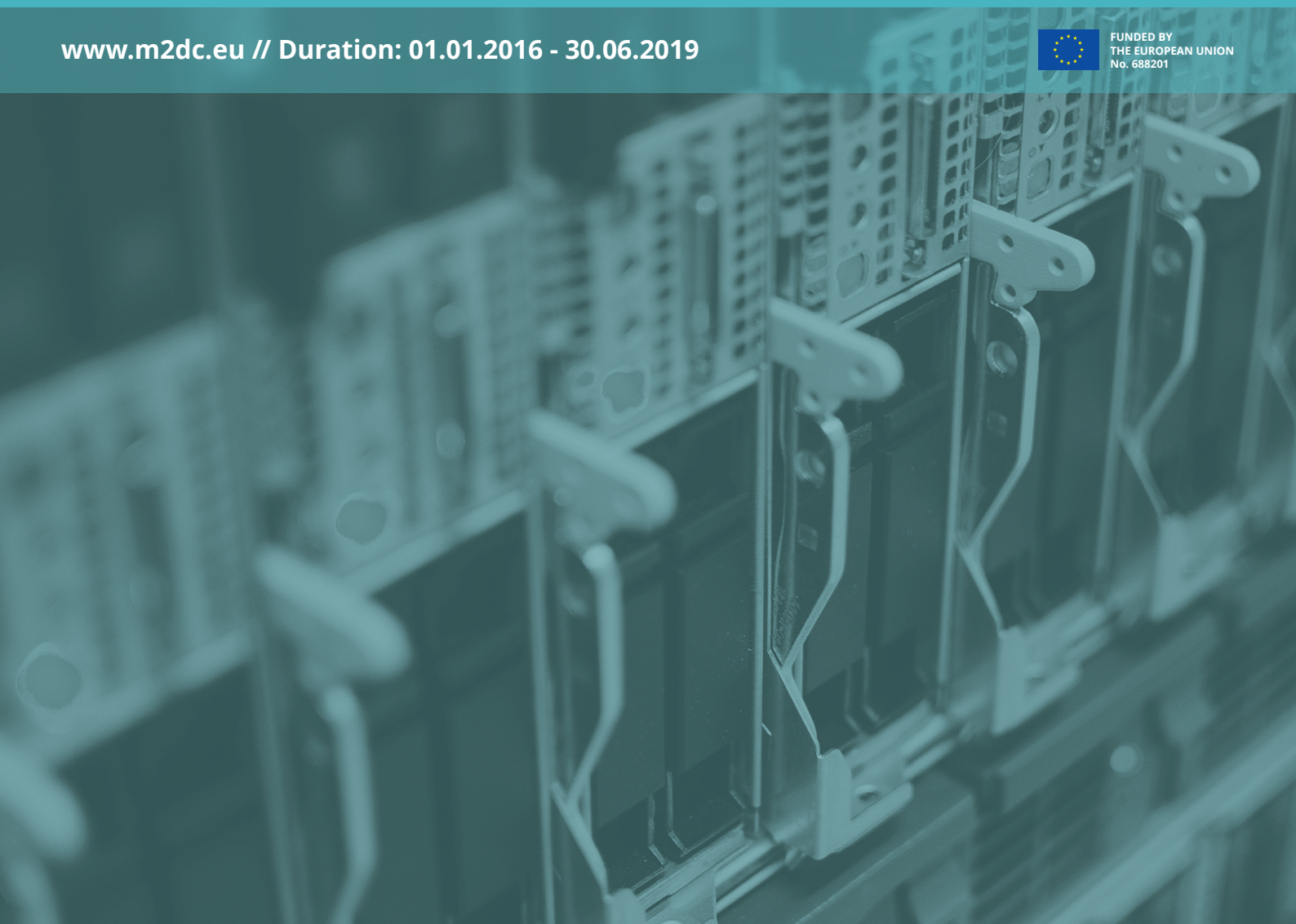
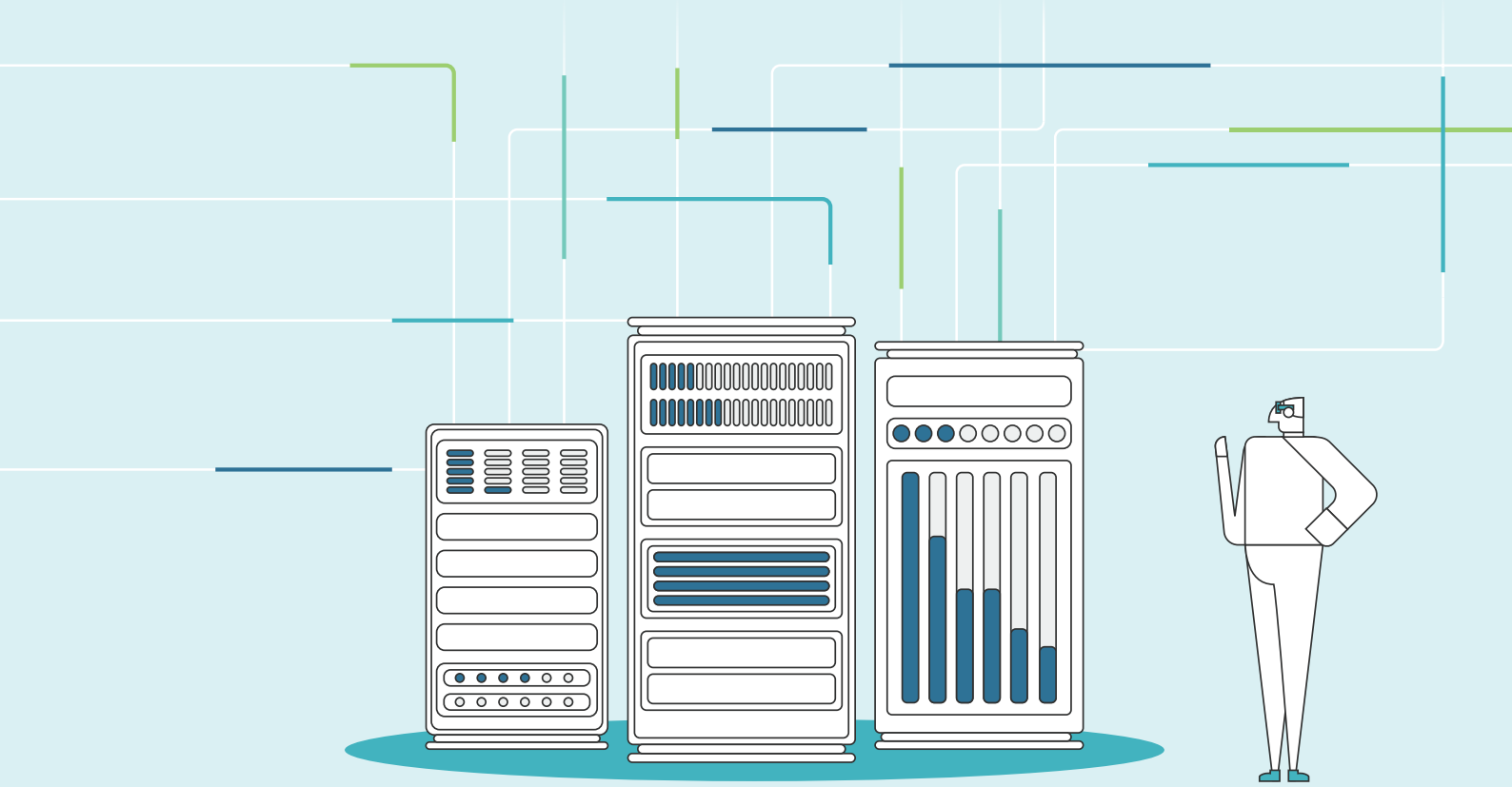


WHAT ARE OUR **CHALLENGES**?

Today's new challenging applications increase demands on the computing performance and energy efficiency of our server platforms. Dealing with more resources, needed for providing required performance and availability, leads to increased energy consumption and higher costs.

M2DC is solving the problem with its new class of low power appliances with reduced Total Cost of Ownership (TCO), being a perfect solution for data centres and HPC data analytics solution providers. M2DC provides significant benefits for data centres, minimising their TCO. This goal is achieved by the use of efficient microservers, easy and cost-effective hardware upgrade possibilities and intelligent energy management techniques integrated with OpenStack middleware. This new, flexible and scalable microserver cluster will permit you to optimize energy efficiency and decrease rack space, while minimizing costs

The M2DC platform enables competitive advantage with respect to performance, scalability, efficiency and cost-savings to applications such as photo finishing service processing several million images per year, data analytics of large real-time sensor data from vehicles, processing HPC workloads and providing Platform as a Service (PaaS) cloud solutions.



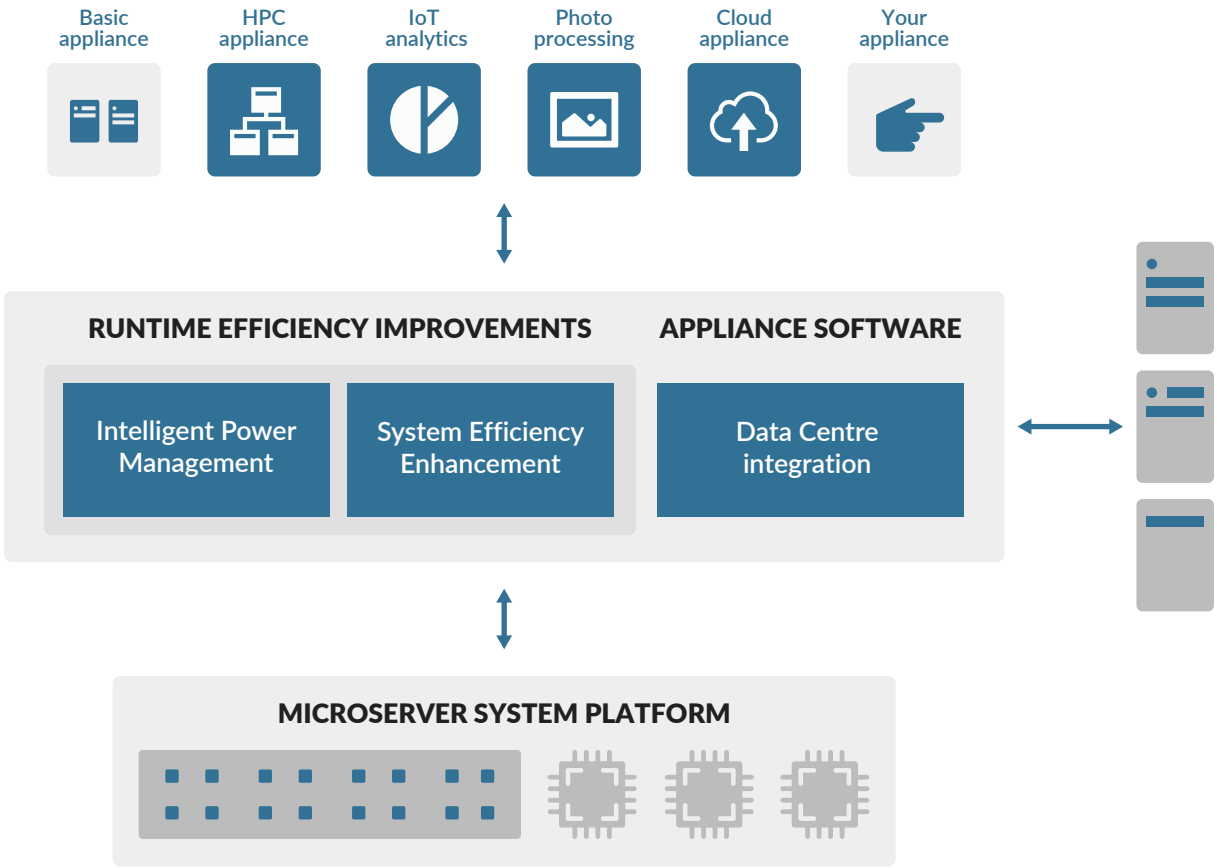
M2DC
CONCEPT

Using an innovative hardware customised software and built-in advanced features, M2DC is based on state-of-the-art technology built over EC funded R&D, using well established technology and having some of its partners (Huawei, ARM and Reflex) building some of the needed components.

Built-in enhancements for perfomance, efficiency and security (including AI accelerators), permit us to take the best out of the available hardware enabling intelligent power management.

It is tailored to requirements of specific industries and real-life applications through preconfigured appliances to HPC, Cloud or IoT.

- New, flexible and **scalable microserver cluster**
- **Low power microserver nodes** (ARM64)
- **Built-in acceleration** (incl. microservers with FPGAs)
- Intelligent **power management**
- **Built-in enhancements** for perfomance, efficiency and security
- **Easy to integrate** with data centre ecosystems
- Tailored to requirements of specific **real-life applications**



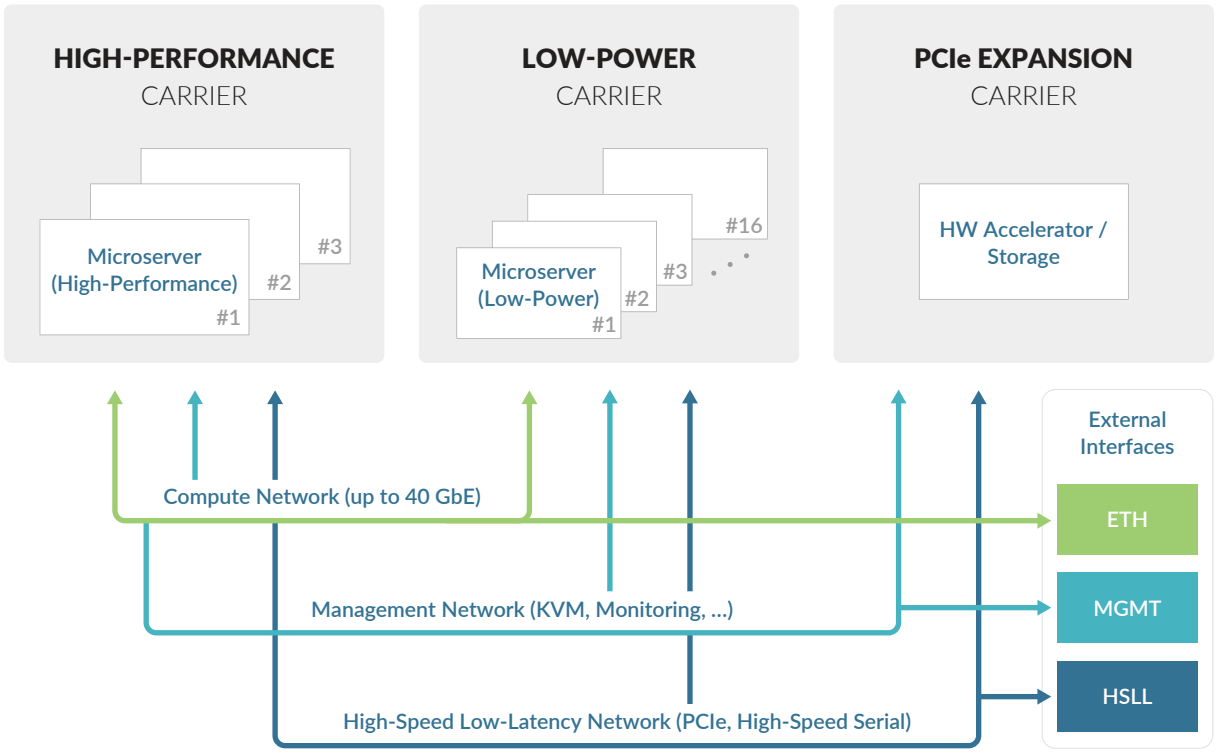
M2DC SERVER **ARCHITECTURE**

M2DC is by designed a high-speed, low latency communication infrastructure, scalable across multiple servers.
The open architecture of M2DC is heterogenous in nature, permitting the usage of a variety of available microservers, with built-in efficiency enhancements and smart termal management.
The M2DC platform is ready to be integrated in worldwide data centres, over hot plug management, and redundancy of power suplies.

- Heterogeneous platform combining ARM64 CPUs and FPGAs
- High-speed, low latency communication infrastructure, scalable across multiple M2DC servers
- Resource efficient, high dense, modular approach

Up to **40** low power microservers

or up to **5** high performance microservers per chassis.



M2DC **APPLIANCES**

The M2DC product is a set of turnkey appliances optimised to relevant classes of applications to address the high demands of emerging technology, offering preconfigured appliances focused on uprising industries such as HPC, IoT and Cloud Computing, addressing their specific needs.

We also make available a base appliance that you can easily install and adapt to your data centre ecosystem, and the possibility to customize an appliance to the needs of your company.

The most relevant components of these appliances have been showcased and demonstrated in the best HPC events throughout Europe and the USA.

And you can also **customize your own** M2DC appliance to fit your needs and workflow.

Basic Appliance
The core of M2DC technology, ready to accomplish the most challenging tasks.

High-Performance Computing
Demanding HPC appliance focusing cost-effectiveness and energy efficiency.

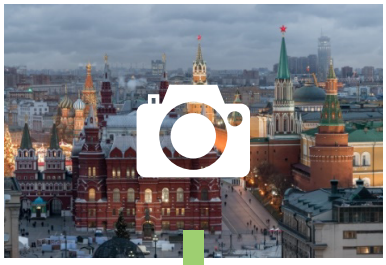
Transport Data Analytics
High-volume, high-velocity computation of real-time analysis focusing IoT sensors and other data sources.

Photo Processing
Efficient and scalable image and signal processing services.

Cloud Computing
Cloud vendors with focus on Platform as a Service based on M2DC micro-server platform equipped with ARM processors.

Your Appliance
Meeting you where your problem is, with the most fit solution to solve it.

IMAGE SCALING
USE CASE



ActiveMQ

Scaled by
NVIDIA JETSON TX2

cewe

In the case of the image processing appliance, our partners CEWE and leaders in the digital photo printing industry, were able to reduce by factor 17x their energy efficiency.

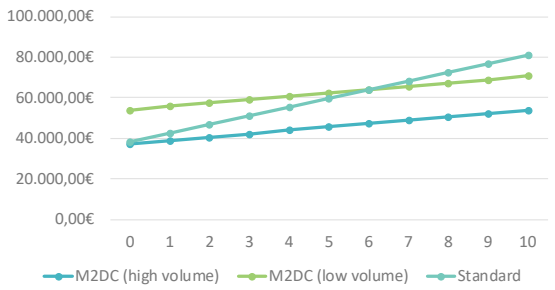
These achievements not only highly reduce their costs and resource availability, but also permit them to integrate a growing community of green IT adopters with large impact.

This is achieved by load prediction to optimize management, ensuring appropriate air flow and node priorities to minimise impact on important nodes.

6x
more energy efficient than standard servers

REDUCED
TOTAL COST OF OWNERSHIP

APPLIANCE
WITHOUT UPGRADE

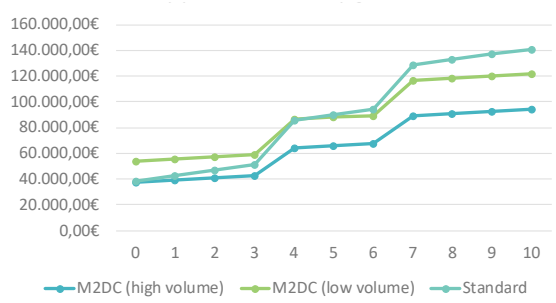


When comparing the M2DC infrastructure to the standard server infrastructure we show up to 67% lower costs in system upgrade.

In fact, the flexible server architecture that can be easily customised, maintained and updated permits that after 5 years the data centre needs only to substitute some of the components.

But even when considering the substitution after 5 years, the maintainability and reliability by design promote M2DC as a more sustainable solution.

APPLIANCE
WITH UPGRADE



The migration and training costs implied by the change to the M2DC systems in some cases are compensated by the high energy efficiency gain in the long run (at least two-fold). Intelligent monitoring and DC integration highly contribute to these gains. Additionally, the relatively high cost for the basic infrastructure of the M2DC server is compensated by the large amount of microservers that can be integrated into one chassis combined with the embedded communication infrastructure.

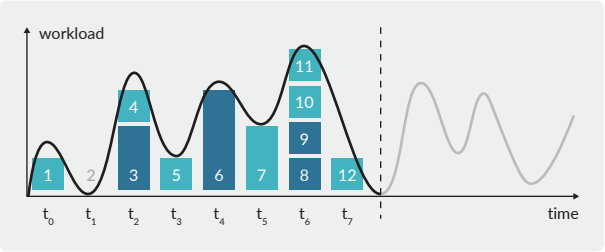
up to **67%**
lower costs in
system upgrade

up to **65%**
savings within server
lifetime

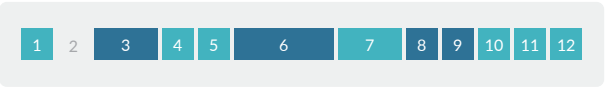
INTELLIGENT MANAGEMENT

The IMG SEE is the central component for increasing the energy efficiency of CEWE's image processing system. While usage of GPUs alone can increase energy efficiency by a factor of 8 compared to x86, the intelligent workload management extension of the OpenStack cloud management platform can optimize the overall efficiency by an additional factor just by adapting the numbers of used nodes to the actual demand. Continuous workload forecastings enable aggressive application scheduling while still meeting service level agreements. Thereby, the Data Mining SEE ensures that the overhead of workload forecasting is minimized.

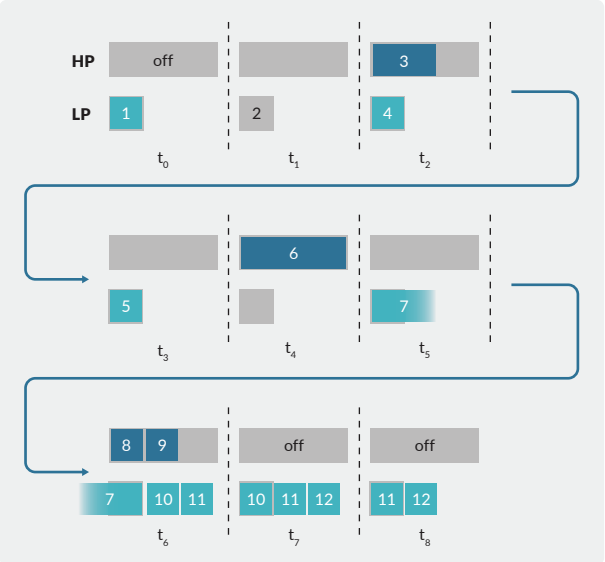
INCOMING WORKLOAD



QUEUE



HW UTILISATION



Workload management

- Use of load prediction to **optimize management**
- Use and **extension of OpenStack** (Nova compute)

Power capping

- Supporting heterogeneous architecture,
  - *e.g. x86 CPU, Intel RAPL, NVIDIA GPU, Tegra*
- Node priorities to **minimise impact** on important nodes
  - *Dynamically configurable through defined API*
- 15-30% energy savings for selected applications

Thermal management

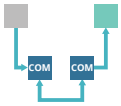
- Keeping temperatures of microservers **below the desired levels**
- Ensuring **appropriate air flow**
- Adapt to heterogeneous configurations

up to **58%** lower operation costs

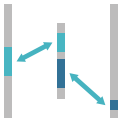
AVAILABLE BUILT-IN **EFFICIENCY ENHANCEMENTS**

Image processing (IMG)
Images are processed to thumbnails on the fly in an energy efficient way, reducing the required data storage.

Intrusion Prevention / Detection Systems (IDS)
Network flows in the M2DC appliance are monitored by a high efficiency implementation of an intrusion detection system for suspicious activity to protect the appliance.



Communication (COM)
Gives M2DC appliances a very fast communication channel with very low latency that is not available neither on HP Mooshot nor bladecentres, even those using InfiniBand or similar networks.



Convolution Neural Network (CNN)
High efficiency accelerator on FPGA microservers for convolution neural networks inference for tasks such as image classification.

Data Mining (DM)
High efficiency implementation of data analysis and load forecasting algorithm, to enable intelligent workload management and reduce operating costs.

Self Organizing Map (SOM)
Scalable accelerator for data mining based on self-organizing feature maps utilizing Intel Stratix 10.

Task/Resource Scheduler (SCHED)
High efficiency last-level scheduling cache with self-healing capabilities and customisable strategies, to efficiently map tasks to the heterogeneous resources of a M2DC appliance.

Pattern Matching (PM)
Fully programmable, fast and energy efficient pattern matching engine with a limited action domain specific language to detect problems on the stream of system monitoring events.

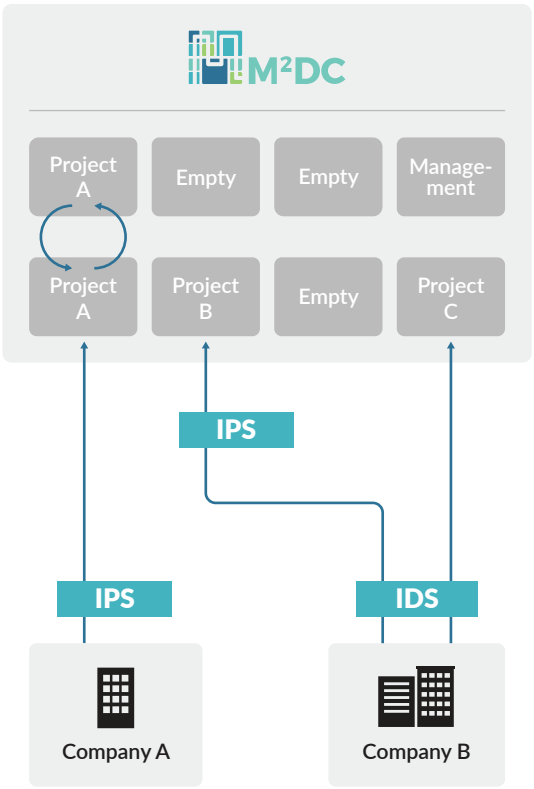
Encryption (CRYPT)
Symmetric and homomorphic encryption on FPGA microservers, for performance and energy efficiency of secure operations and data transferts in a M2DC appliance.

Software Distributed Shared Memory (S-DSM)
Easily program for a mix of x86 and ARM CPUs, low power and high power, in a M2DC appliance with a single system view of the microsevers memory and acceleration capabilities.

Message Passing (MP)
Offload collective operations to M2DC acceleration resources to reduce energy use, improve latency and optionnally decrease floating point errors.

SECURITY

Network security is of the utmost importance, everywhere. The knowledge of what is going on inside your private network is invaluable. Due to the fast development and introduction of new technologies, the pool of potentially vulnerable applications and protocols is quickly increasing. Firewalls alone can't provide network protection. The M2DC platform includes Intrusion Detection and Prevention systems (IDS/IPS) that can detect anomalies in internal networks, for incoming (before the fact) and outgoing traffic (after the fact). When IPS is enabled the alarms permit to actively block the unwelcome traffic. At M2DC we take security very seriously. Our security appliance is based on the next-generation firewall solution Suricata. This means cost-optimised server architecture enabling seamless integration of IDS/IPS systems with the microservers. The multi threaded approach of Suricata allows a significantly high throughput and is capable of real time 10 Gbit and faster network traffic inspection.



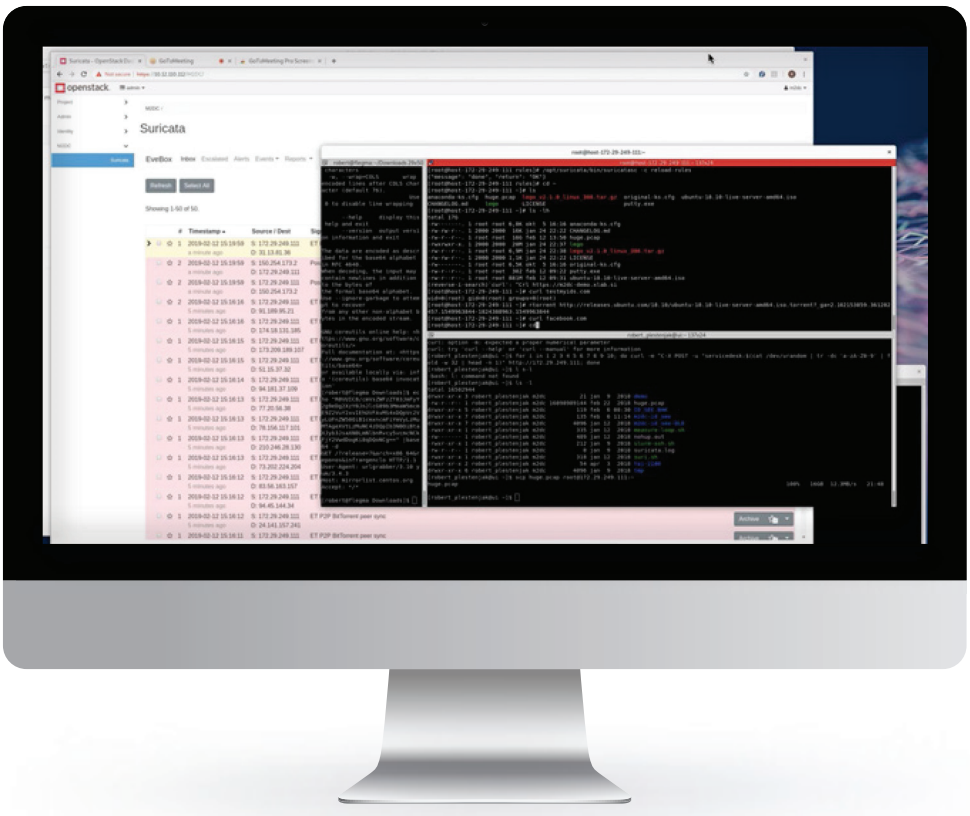
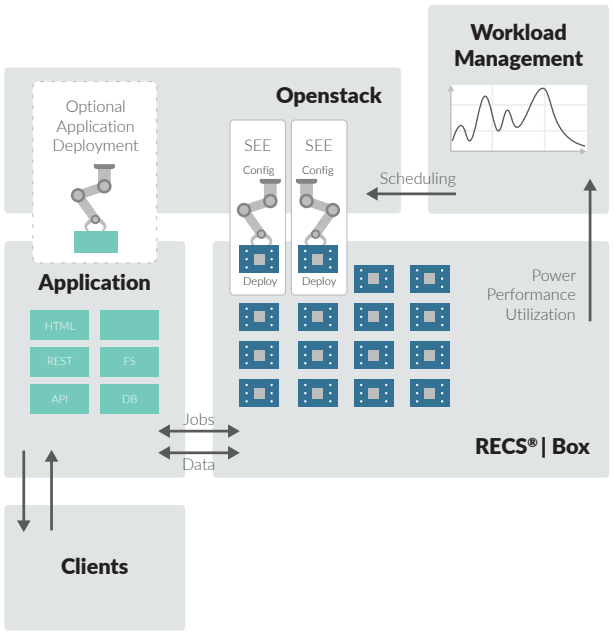


IMAGE PROCESSING
APPLIANCE



Objective

- **Scalable** photo finishing
- Use case from **leading** online photo service and digital print service
- Execute **image processing** tasks like scaling, cropping and rotating
- Using **built-in accelerators** for fast and efficient processing

Workflow

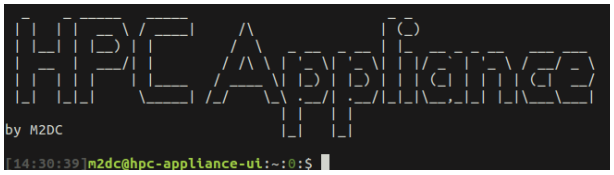
- Tasks requested via REST API
- Transfer images to/from appliance via that API

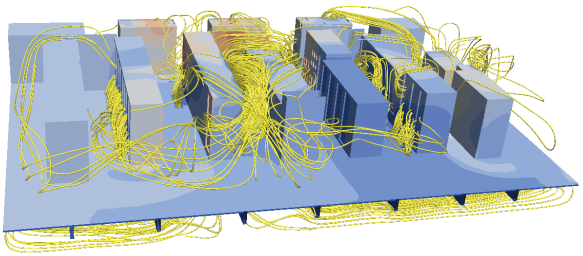
Implementation

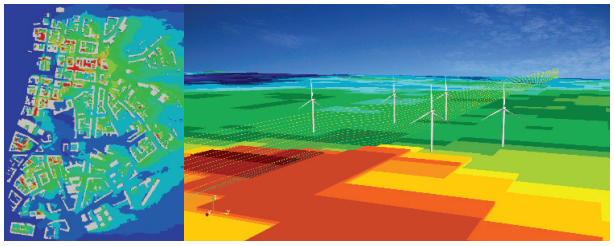
- Integrated image processing functions
  - *Running on ARM CPU+GPU (NVidia Tegra TX2)*
- Integration into CEWE application shows huge potential
- Standalone API server implemented
- FPGA implementation studied

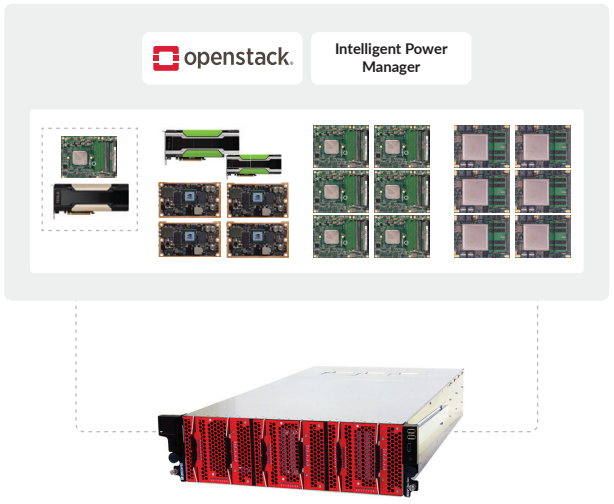
64% less savings within server lifetime saving more than 180k

HPC
APPLIANCE









Objective

- Provide platform with **common HPC tools and libraries** that allow running compute-intensive batch applications using M2DC optimizations
  - *Using **built-in features** such as fast communication (PCI Express*
  - *Designed as HPC cluster*
- E.g., meteorological simulations used in **predicting** energy production and air pollutionst

Workflow

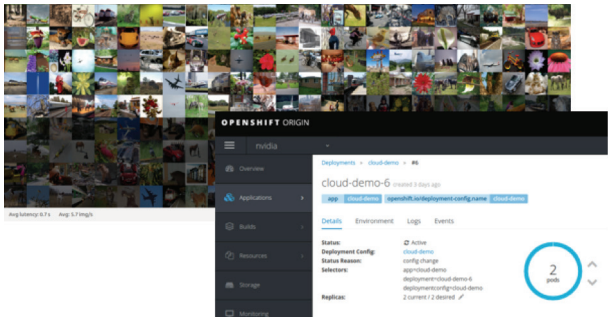
- User logging into headnode
- Jobs can be scheduled for execution on worker nodes, optionally requesting M2DC built-in features (SEEs)

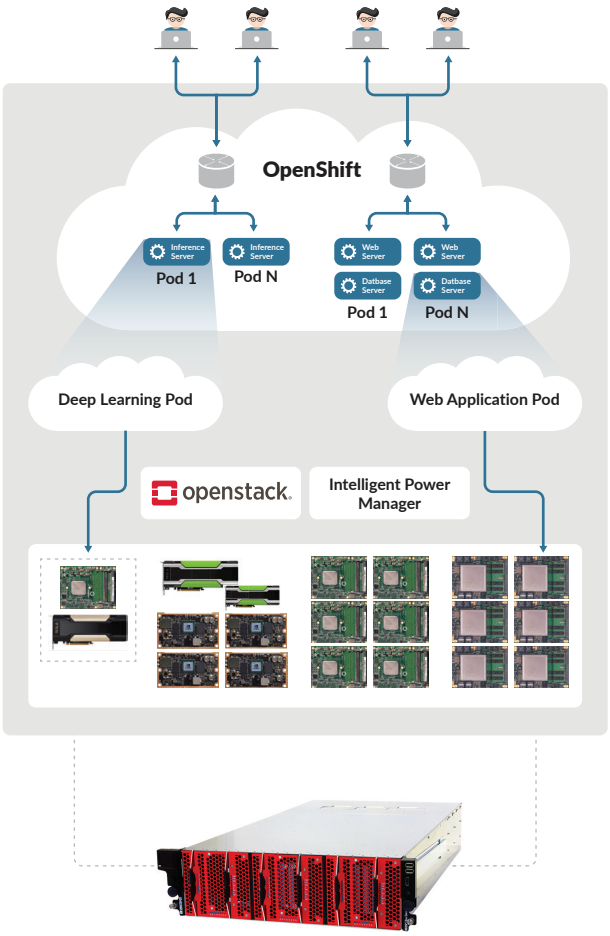
Implementation

- Pre-configured job scheduler SLURM and other components
- Integration of M2DC built-in features (SEEs) as plugins to SLURM
- Tests of HPC applications and benchmarks

65% less savings within server lifetime saving more than 170k

CLOUD APPLIANCE





Objective

- **Easy provisioning of containers** on M2DC compute nodes for external users
- **Fine-grained management** of resource allocation
- Two main use cases we target:
  - *web applications (e.g. on ARM64*
  - *deep learning accelerated by GPUs*

Workflow

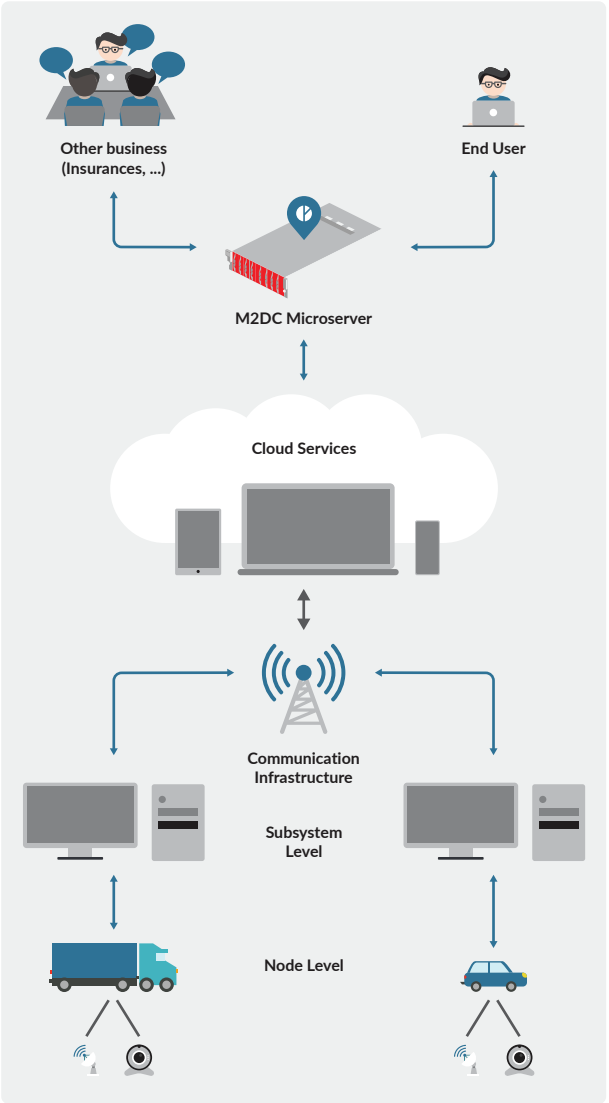
- a user is developing a web service and doesn't want to focus on infrastructure
- with cloud appliance they are free to choose the right code development environments
- they enjoy agile development with greater availability, scalability and control over their infrastructure

Implementation

- Platform as a Service (PaaS) environment setup using OpenShift/Kubernetes
- Generic ARM64 appliance images are being created
- Integration with the use of heterogeneous resource investigated
  - *e.g. machine learning tools from the NVIDIA Cloud*

63% less savings within server lifetime saving more than 300k

IOT DATA ANALYTICS
APPLIANCE



Objective

- Analysis of data from **large numbers** of sensors
- Use in **transport** (e.g. data for insurance companies)
- Use case based on Vodafone solution for drivers' **behaviour analysis**
- Provide **optimized "R" scripting environment** for data analytics
  - *Including optimized data clustering algorithms*
- Provide **data generator** for test data
- Utilizing **GPU**

Workflow

- User logging into headnode
- R based jobs can be scheduled for execution on worker nodes using optimized R environment

Implementation

- Environment integrated and working on CPU (x86/ARM64) and GPU
- Algorithm optimization

46% less savings within server lifetime saving more than 150k

M2DC FITTING YOUR **NEEDS, RESOURCES AND BUDGET**

The M2DC platform is served with three capacity options that take in consideration the different needs of the customer, as well as the available assigned budget, and available data centre space. In that, the M2DC offer is dynamic enough to fit in the specific interests and problems that the customer considers, and can better fit its workflow and size of production/ service.

The Basic chassis is mainly used for small use-cases and can also serve as an evaluation platform. However, it is not optimized with respect to microserver density. The Mid-Range Chassis option is optimized for higher microserver density and provides extensive communication towards others M2DC servers in the same rack or datacentre. The scaleout chassis offers highest microserver density, however, is very demanding in terms of rack cooling capacity. Therefore, the scaleout chassis is best for large-scale installations in space-constrained datacentres with high cooling capacity.

- New, flexible and scalable **microserver cluster**
- **Turnkey appliances** optimised to relevant classes of applications
- Significant improvements in **performance and energy efficiency** - reduced TCO

BASIC CHASSIS

Greatly efficient and with lower cost.

3
Carriers

9
High-Performance Microservers

48
Low-Power microservers

MID-RANGE CHASSIS

Ready for the most demanding challenges.

9
Carriers

27
High-Performance Microservers

144
Low-Power Microservers

SCALEOUT CHASSIS

The most powerful option.

Developing for you!

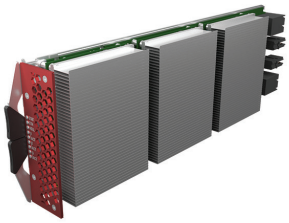
15
Carriers

45
High-Performance Microservers

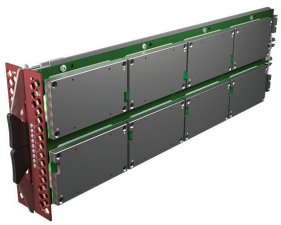
240
Low-Power Microservers

M2DC
COMPONENTS

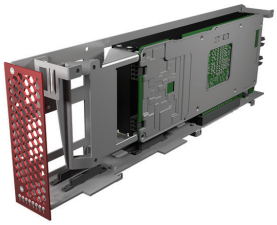
CARRIERS



High-Performance Carrier
(up to 3 Microservers)

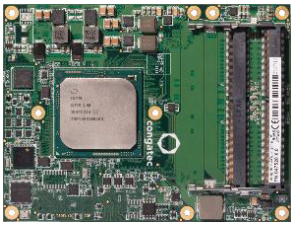


Low-Power Carrier
(up to 16 Microservers)



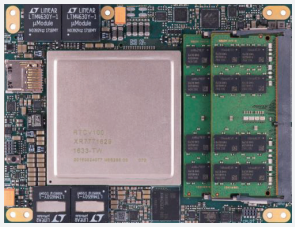
PCIe Expansion Carrier
(1 Accelerator)

HIGH-PERFORMANCE MICROSERVER



x86
Intel Xeon

M2DC Microserver



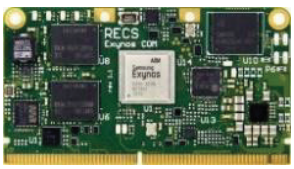
ARM v8
32 Core Cortex-A72

M2DC Microserver

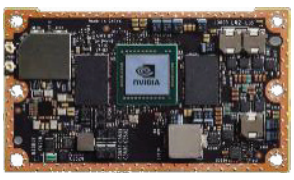
FPGA SoC
Intel Stratix 10

LOW-POWER MICROSERVER

FPGA SoC
Xilinx Zynq



ARM SoC
Samsung Exynos



GPU SoC
Nvidia Tegra

EXPERIENCING **M2DC**

Stefan Wesner

Prof. at the Institute for Organisation and Management of Information Systems, Ulm Univ.

"The approach proposed by the M2DC project seems to be interesting to emerging areas such as edge computing and its use in industry 4.0, in particular smart production systems. In this case processing is inside the industrial environment with data collection and analytics. In particular, the small companies with very good engineers but with not enough IT knowledge could gain from pre-configured appliances.."minimisation objectives and emerging regulations."

Andrew Donoghue

Former European Research Manager Advisory Board of the M2DC Project

"M2DC rightly recognises that homogenous, commodity architectures will not be sufficient to meet the compute requirements of the next generation of IT workloads. The goals of M2DC fit well with the current push to develop new, highly efficient, heterogeneous application-specific architectures for emerging workloads such as IoT, machine and deep learning, and big data analytics."

WHO
WE ARE

M2DC is easy to integrate with a broad ecosystem of software used in data centres and fully software-defined to enable optimisation for a variety of future demanding applications in a cost-effective way. It investigates, develops and demonstrates a modular, highly-efficient, cost-optimized server architecture composed of heterogeneous microserver computing resources, being able to be tailored to meet the most demanding IoT requirements, as well as from various other application domains, such as image processing, data analytics, cloud computing or even HPC.

The success of M2DC is the best market positioning against competitive solutions in the open market, with identified and well established B2B relationships and customer/community base.

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