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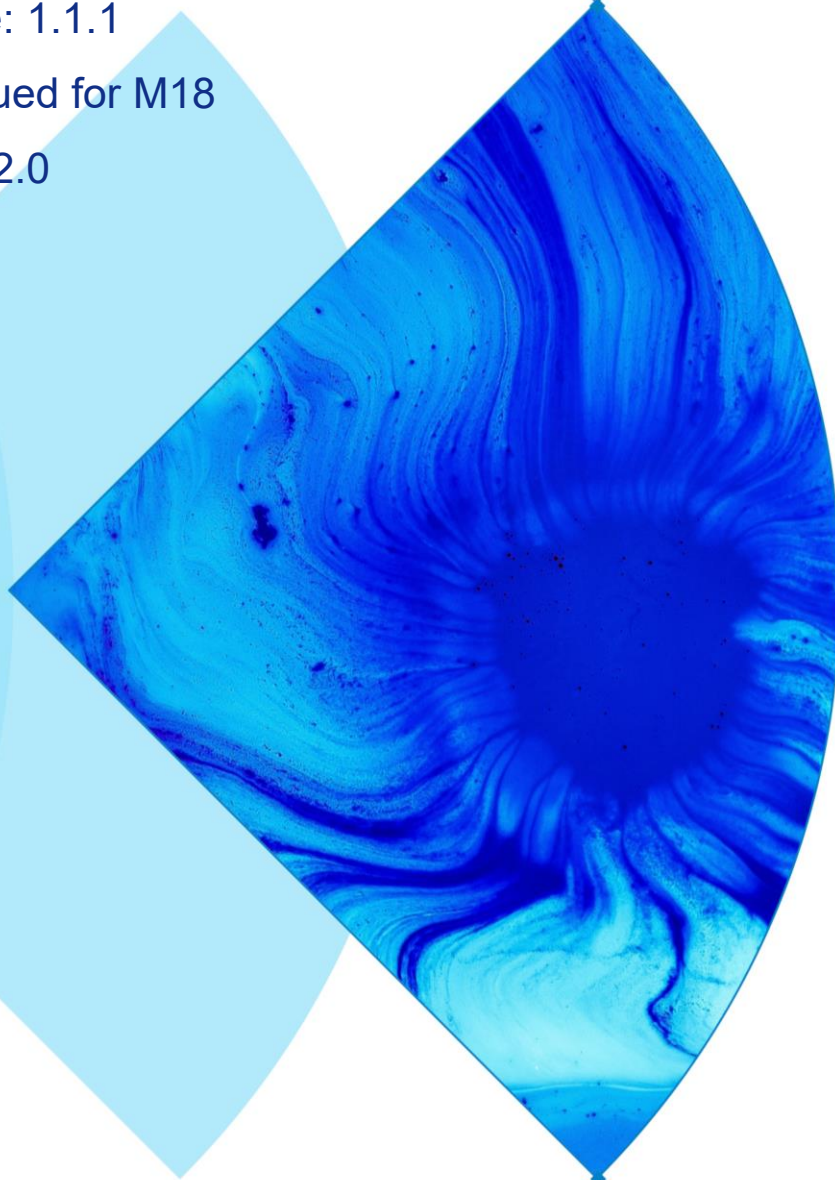
MISD Edge Data Centres

Technical Feasibility Study

Deliverable: 1.1.1

Status: Issued for M18

Version: v2.0



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Terms and Abbreviations

Abbreviation	Description
AI	Artificial intelligence
AR	Augmented Reality
AWS	Amazon web services
CAGR	Compound annual growth rate
COLO	Colocation
eDC	Edge data centre
EDCaaS	Edge data centre as a service
GDCE	Google distributed cloud edge
GDPR	General Data Protection Regulation
IoT	Internet of Things
ISO	International Organization for Standardization
ML	Machine learning
ROI	Return on investment
Telecom	Telecommunications

Introduction

Background

As digital transformation grows across industries, the demand for faster and reliable data processing is growing too. This is driving the need for edge data centres in the Netherlands and across Europe. There is particular interest in making edge data centres widely used, as they offer a crucial solution to the region's space constraints. Traditional hyperscale data centres centralize computing power in remote locations, while edge data centres bring data storage and processing closer to the end-users. This reduces latency and eases the strain on hyperscale data centres. This is critical for applications like autonomous vehicles, smart cities, and the Internet of Things (IoT).

Executive Summary

This report outlines a high-level market research on modularity, innovation, and market readiness for edge data centres, as well as a staging and field lab. The study of work package 1 aims to define the design requirements for a modular edge data centre that is aligned with the findings of the aforementioned research. It is conducted alongside Eurofiber's implementation of the staging lab within their existing facility in Arnhem, on Tivolilaan 251.

The market research will provide insights into the current eDC market size and growth potential, key existing players, market trends, innovation benchmarks, and the regulatory landscape. These insights will guide the development of the Staging Lab phase of Work Package 1, ensuring alignment with industry advancements and future regulatory changes.

Market Research

Edge Data Centre Market Size and Growth

The edge data centre market is expanding rapidly due to 5G rollouts, artificial intelligence usage, IoT adoption, and the need for real-time data processing. The global eDC market was valued at \$10.4b in 2023 and is projected to reach \$29.6b by 2028, with a CAGR (compound annual growth rate) of 23.2% ([MarketsandMarkets, 2024](#)). (Using 2022 as the base year for estimation).

Key drivers of growth include:

- The rise of ultra-low latency applications (e.g. autonomous vehicles, AR - augmented reality, real-time data processing).
- Increasing data localization requirements (e.g. GDPR compliance) and reduced reliance on foreign cloud services
- Impending energy efficiency regulations that are driving the need for more sustainable infrastructure in the EU. Lower PUE and WUE restrictions by 2030.

The EU market is seeing an accelerated demand, particularly in the Netherlands, Germany, and France, where connectivity hubs and regulatory incentives steer towards decentralized computing over traditional hyperscale data centres.

Market players and shares

The eDC market is highly competitive, with key players from hyperscalers, telecom operators, colocation providers, and modular infrastructure vendors:

- Hyperscalers and Cloud Providers
 - AWS local zones, Microsoft azure edge zones, Google distributed cloud edge, IBM cloud satellite
- Telecom operators and 5G Edge providers
 - AT&T, Verizon, Vodafone
- Colocation and Edge data centre operators
 - Equinix (xScale), EdgeConneX, Digital Realty
- Modular and prefabricated edge solutions
 - Schneider Electric, Vertiv, Huawei (Fusion modules)

In Europe, telecom and colocation providers are investing in regional edge deployments to meet data sovereignty and low-latency processing demands.

Existing operational EDC's

Edge data centres have been deployed worldwide by telecom providers, cloud companies, and enterprises.

- AWS local zones: distributed edge cloud regions in urban areas for low-latency cloud processing.
 - Local zones are a way for AWS to offer their cloud services closer to users in specific cities or regions. This setup helps reduce latency when accessing apps or data, which is important for tasks that need fast, real-time processing. Located in major cities, Local Zones provide a range of AWS services like virtual servers, managed databases, and container management. By using Local zones, businesses can make their applications run faster and more smoothly for people in that area.

- Google Distributed Cloud Edge: Supports real-time AI/ML processing and 5G network functions.
 - GDC is a set of ready-to-use hardware and software tools that let businesses use Google cloud services outside of Google's own data centres. This means they can run these services in their own buildings, in remote locations, or in places with strict security or privacy rules. GDC helps companies upgrade their systems and apps by moving cloud technology closer to where their data is created or used.
- Equinix xScale Edge: A carrier-neutral, low-latency edge interconnection solution.
 - xScale data centres provide access to a comprehensive suite of Interconnection and Edge services that integrate with a hyperscale company's existing access points at Equinix. xScale also enables businesses to manage or outsource their operations through Equinix's Smart Hands services.
- EdgeConneX Edge Data Centres: Located near major metro areas, reducing latency and enhancing cloud performance.
 - EdgeConneX builds data centres that are specifically designed to meet the needs of their service provider customers, helping them place their network and IT systems in the best locations for performance and efficiency. They work closely with each customer to set up their systems closer to where users are physically located.
- Schneider Electric EcoStruxure Micro Data Centres: Pre-integrated modular solutions for industrial, retail, and remote deployments.
 - EcoStruxure Micro Data Centres are all-in-one IT setups that include power, cooling, security, and monitoring in a single cabinet. They offer a simple way to build a complete system in one compact unit. Because they take up less space, these data centres can be installed almost anywhere. A tool called the IT Professional Edge Configurator helps quickly plan and set up the system to match specific needs. Users can also monitor and manage everything remotely, making it easier to make smart, data-based decisions.

These facilities all emphasize ultra-low latency, security, and scalability to support real-time applications. These solutions typically make use of traditional air cooled or in-row systems, which poses a potential difficulty when imminent PUE regulations are to be instated.

Key Considerations

Modularity

Modularity determines the ability to deploy scalable, prefabricated, and standardized units that can be easily expanded based on the foreseen demand. Unlike traditional data centres, which require large-scale infrastructure investments, modular edge solutions offer a type of 'plug-and-play' approach, significantly reducing deployment time and capital expenditure for those wishing to make use of an eDC.

Key Trends

- Containerized edge data centres: adoption of micro data centres housed in ISO containers enables rapid deployment in remote or urban locations, supporting applications like 5G, smart cities, and industrial IoT
- Prefabricated modules: vendors such as Schneider Electric and Vertiv are introducing prefabricated data centre modules integrating power, cooling, and networking infrastructure to streamline the implementation process
- Scalability and flexibility: modular edge data centres are designed for incremental expansion, ensuring businesses can scale their infrastructure as demand grows without significant upfront investment.

Market Adoption

- Telecom providers and cloud companies: With the rise of 5G networks, telecom operators and cloud providers are increasingly deploying modular edge solutions to enhance content delivery and reduce network congestion
- Specific sectors and AI usage: Industries requiring real-time AI processing, such as autonomous vehicles, healthcare and manufacturing, are driving the demand for edge data centres to minimize latency and optimize computing power

Innovation

New Technologies

- AI-Driven monitoring and automation
 - Predictive analytics and AI-powered monitoring are being integrated to optimize power efficiency, cooling, and maintenance. This reduces operational costs and downtime
- Advanced cooling techniques
 - An increasingly popular solution is direct-to-chip cooling to improve energy efficiency and reduce environmental impact. Data centre owners are opting to build 'DLC ready' data centres.
 - Liquid immersion cooling solutions are gaining traction, particularly in high-density compute environments that require efficient heat dissipation
- Renewable energy integration
 - Many modular edge deployments are incorporating solar panels, wind energy, and battery storage to reduce reliance on traditional power grids, addressing sustainability concerns and power constraints

Design Considerations

- Efficient space utilization: Given limited real estate availability in Europe, it is essential to provide compact and high-density IT solutions to maximize performance
- Zoning regulations: building codes vary across regions and can delay approvals for building plans.
- Resilience: The modular eDC will need to withstand various urban, rural, commercial or industrial conditions
- Security: Potential physical and cyber security threats need to be addressed in a realistic manner. The chosen solution will meet a minimum SLA (service level agreement) for this to be a viable eDC
- Cooling solution: Liquid immersion or direct to chip cooling preferred over traditional air cooled systems
- Power availability: The modular eDC will need to be aligned with current and future grid capacity to be considered within local municipal planning. Access to reliable power varies across remote locations
- Standardization/Modularization: Ensuring that hardware and software is consistent across sites will make management easier
- Cost management: it is key to justify the ROI based on number of users being served

Opportunities

The volume of data is growing exponentially, and businesses need access to data centre facilities to keep up with this demand. EDCaaS (edge data centre as a service) is an existing model that offers organizations the chance to make use of eDC COLO facilities using a cloud based model that enables the user access to edge computing resources using a 'pay as you go' system. Users can tap into data processing services, network services, and data storage without needing to build or manage their own facility. Reducing major capital investments and skills outsourcing, this is a cost efficient solution, with a faster deployment time for small to medium-sized businesses. This solution is particularly beneficial in a region like Europe, where organizations are subject to rigid data privacy laws, ie: the GDPR. Amazon, Microsoft and Google (and various other specialists) already offer EDCaaS for users, with flexible options tailored to the business's needs. Larger businesses typically opt for a hybrid solution, with a mix of on-site data management and cloud based services. A prefabricated solution also offers the opportunity for scaling or relocation based on business growth.

Market readiness

Drivers

- Expansion of 5G and IoT: The increasing number of connected devices and real-time applications is driving the need for localized processing at 'the edge'.
- Data sovereignty and regulations: European regulations such as GDPR (general data protection regulation) compliance and country-specific laws require localized data processing, making edge deployments more attractive
- Ultra-low latency applications: AI, cloud gaming and autonomous systems require response times within milliseconds, which traditional cloud data centres struggle to provide.

Challenges

- Power and cooling limitations: many distributed locations lack adequate power supply, requiring alternative energy solutions.

- Integration with existing infrastructure: edge deployments must seamlessly connect with hyperscale cloud providers and on-premise enterprise systems.
- High initial costs: While modular edge data centres reduce deployment time, initial investment remains a key concern, particularly for smaller enterprises.
- Standardization/modularization: A standard solution is not always possible due to site differences and context.
- Maintenance and management: On-site support may not always be readily available depending on site location and accessibility. Remote monitoring requires robust connectivity and will incur higher costs

Staging and field lab

Purpose and Scope

The staging lab will act as a controlled environment to test, validate, and refine modular edge data centre technologies before a full-scale field deployment. Located at a Eurofiber facility, the lab will facilitate:

- Evaluation of modular architecture (containerized solution)
- Testing of new cooling, power, controls and security solutions under real-time conditions
- Assessments for hardware and software integration
- Optimization of IT capacity (in kW/m²)
- Simulation of heat loads
- Waste heat reuse potential
- Identifying key design challenges

Design Requirements

Size and Layout

- 20 foot / 20 foot (increased width) / 40 foot standard ISO container, optimized to accommodate:
 - Prefabricated IT racks, liquid cooled compatible.
 - Networking and security hardware.
 - Power and cooling systems.
 - Controls and monitoring systems.

Infrastructure Needs

- Power Supply:
 - Redundant UPS and battery backup for reliability and to minimize potential downtime.
 - Potentially smart grid 'ready' - for improved grid balancing.
- Cooling and Heating Technologies:
 - Liquid-cooled configurations.
 - Integration of heat waste reuse systems.
- Connectivity and Security:
 - *Outside of Deerns scope; within BetterBe and Eurofiber's scope*

Scalability and Flexibility

- Interchangeable modules and sizes, compatible within different contexts.
- Support for future hardware upgrades, without major infrastructure modifications.



Figure 1: Existing staging lab setup

Next Steps

This feasibility study highlights the need for modular, scalable edge data centres and the role of testing emerging cooling technologies in the staging and field lab. Given the aforementioned market trends, the next steps include:

- Refining and finalizing design specifications based on the staging and field lab findings. To be further developed in the Design Requirements Report, part of work package 1.
- Planning phased implementation of eDC's across the Netherlands (and wider Europe)

After investigation of the eDC market and by identifying various key challenges—land constraints, power limitations, and regulatory requirements—this feasibility study confirms the direction in which the data centre field is heading towards and provides an opportunity to meet this growing demand.

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