



Smart Assistant for Kinetic Home Automation

LUMION ROBOTS Ltd

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August 2025

Modern Management of IT course

Master's Degrees in Information Technology

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Smart Assistant for Kinetic Home Automation

Jyväskylä: Jamk University of Applied Sciences, August 2025, 14 pages

Master's Degree Programme in IT (Cyber, AIDA, Fullstack Software Development, Robotics)

Permission for open access publication: No

Language of publication: English

Abstract

This document is a description of a fictional company called Lumion Robots to which students will implement their group work on the course Modern Management of IT.

Keywords/tags (subjects)

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Miscellaneous (Confidential information)

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1 Introduction to Company

Lumion Robots Oy is a Finnish technology pioneer company specializing in the development and integration of advanced home robotics solutions. Founded with a visionary goal to transform everyday living through cutting-edge innovation, Lumion Robots is dedicated to enhancing convenience, efficiency, and connectivity within households worldwide.

By leveraging state-of-the-art robotics technology, Lumion Robots aims to simplify routine tasks, empowering individuals to focus on what truly matters in their lives. At the core of the company's expertise lies a seamless integration of hardware and software, creating a robust full stack platform that enables smooth interactions between intelligent home robots and users.

Lumion Robots's products are designed to evolve with user needs, utilizing artificial intelligence and machine learning to deliver personalized, intuitive, and adaptive experiences. This fusion of intelligent automation with user-centric design exemplifies the company's commitment to pushing the boundaries of home automation technology.

As the company continues to grow, Lumion Robots remains firmly anchored in its core values of innovation, quality, and ethical responsibility. It not only strives to develop high-performance, reliable products but also prioritizes customer satisfaction and sustainable business practices. By fostering a culture of collaboration and continuous improvement, Lumion Robots aspires to become a global leader in home robotics, shaping the future of technology in households worldwide.

2 Company Visioneering

2.1 Company Vision

Lumion Robots envisions revolutionizing everyday life by bringing intelligent home robotics into households worldwide. The goal is to enhance convenience, efficiency, and connectivity through advanced technology, improving quality of life globally.

2.2 Mission Statement

The company's mission is to develop innovative home robotics solutions that seamlessly integrate into daily life. By automating routine tasks and providing personalized experiences, Lumion Robots empowers users to focus on what truly matters.

2.3 Company Values

The Lumion Robots is guided by five core values:

- **Innovation** – Continuously pushing technological boundaries to lead in home robotics.
- **Customer-Centricity** – Prioritizing user needs and exceeding expectations.
- **Quality** – Delivering reliable, durable, and high-performing products.
- **Collaboration** – Fostering teamwork and strong partnerships to drive progress.
- **Ethical Responsibility** – Operating with transparency, accountability, and environmental awareness.

2.4 Company Strategy

Lumion Robots pursues a strategic path focused on continuous innovation, robust product development, intelligent data use, market growth, customer satisfaction, and sustainability — all driving toward global leadership in home robotics.

2.4.1 Product Innovation

Lumion Robots prioritizes continuous R&D to advance home robotics, focusing on user-centric design. AI and machine learning are central to enabling intelligent automation and adaptability in products.

2.4.2 Fullstack Software Development

The company develops a dedicated full stack platform for home robotics, ensuring seamless hardware-software integration. Ongoing updates enhance security, performance, and user experience.

2.4.3 Data Utilization and Privacy

User data is collected responsibly to personalize interactions and optimize robot performance. Strong data protection practices—encryption, anonymization, and compliance—ensure privacy and trust.

2.4.4 Market Expansion

While market strategy supports growth, it also informs product design by identifying evolving user needs across demographics and regions.

2.4.5 Customer Experience

Feedback loops from users guide iterative improvements in both hardware and software. Technical support and educational resources further enhance product usability and adoption. Systems are also tested automatically and manually.

2.4.6 Sustainability and CSR

Sustainability principles influence design choices—such as energy efficiency and material selection—within robotics hardware development.

Green coding is an environmentally sustainable computing practice that seeks to minimize the energy involved in processing lines of code. Applying Green coding principles programming aims for efficiency and energy saving.

3 Organization

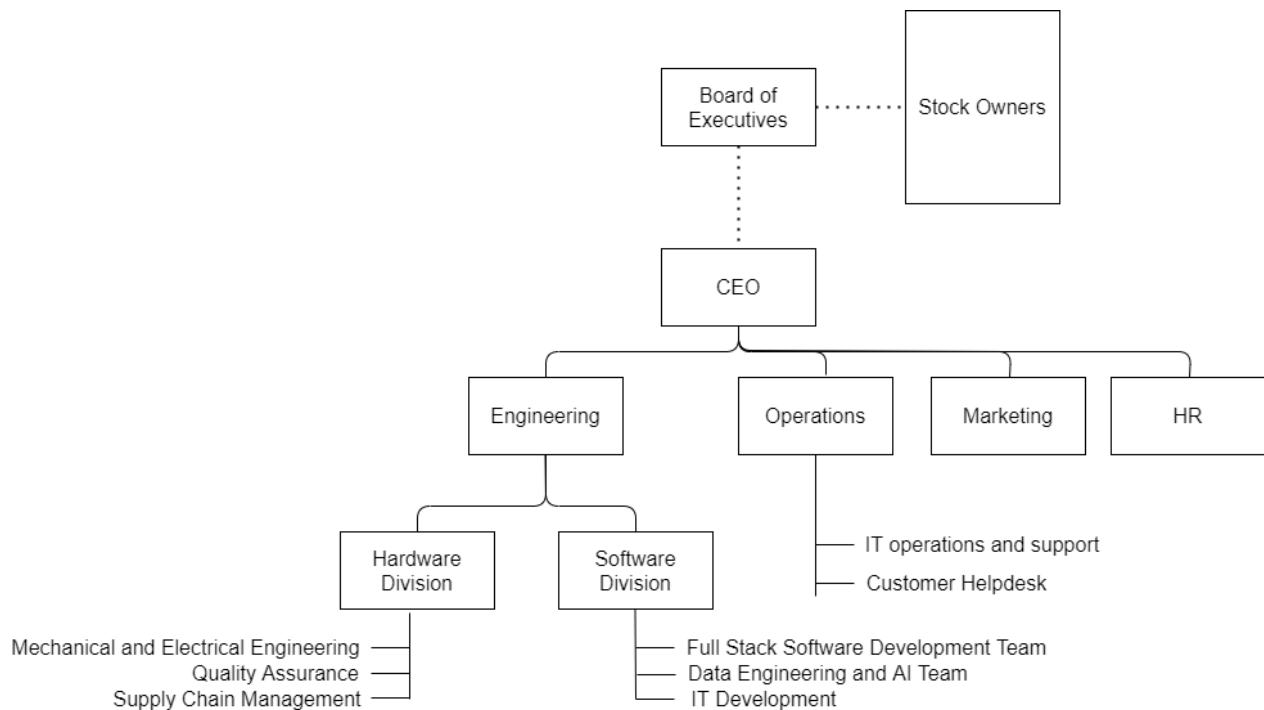


Figure 1 Lumion Robots Ltd organization structure

The organizational structure of Lumion Robots supports innovation and smooth collaboration across different industries. The management level responsibilities are clearly divided:

- The **CEO** is responsible for the strategic direction and overall vision of the company.
- The **CTO** leads technology and device development; he/she reports to the mechanical and electrical design teams as well as production and quality management responsibilities.
- The **Head of Software Engineering** is responsible for the entire software development, including backend, frontend and IT infrastructure, ensuring seamless interaction between software and hardware.
- The **CDO** leads the data and artificial intelligence team, which focuses on data management, analytics and integration of AI/ML solutions to develop intelligent automation.
- The **CMO** leads the marketing and customer support teams that support sales and customer satisfaction.
- The **COO** is responsible for internal IT functions and customer service, ensuring the smooth operation of the organization.

The structure enables teams to collaborate effectively on hardware, software, and data development, which accelerates innovation and the delivery of a high-quality, integrated product to market.

4 Development tools

4.1 Robotic Software Platform

Lumion Robotics Platform (LRP) is the company's unified software architecture designed to power a diverse range of home automation robots, including robotic lawnmowers and vacuum cleaners.

Built on modular principles, LRP enables:

- **Shared core functionalities** such as navigation, obstacle detection, route planning, and over-the-air (OTA) updates
- **Device-specific extensions** that tailor behavior for outdoor (lawnmowers) or indoor (vacuums) environments
- Seamless **integration with mobile apps and cloud services**, ensuring consistent user experiences across all devices

LRP provides a foundation for:

- Reusable AI models for behavior adaptation
- Real-time telemetry and status monitoring
- Remote diagnostics and fleet updates

The platform is built with scalability in mind, allowing Lumion Robots to accelerate development cycles and maintain consistency across its growing product family.

4.2 Cloud Computing Infrastructure

Lumion Robots has developed its full stack software solution to be as **cloud-agnostic** as possible, ensuring flexibility, portability, and resilience across different infrastructure providers. The platform can be seamlessly deployed and run on major public cloud services such as **Amazon Web Services (AWS)**, **Microsoft Azure**, and **Google Cloud Platform (GCP)**.

Each supported cloud environment provides scalable computing resources, including:

- **EC2** instances on AWS
- **Virtual Machines** on Azure

- **Compute Engine** on GCP

For storage needs, Lumion Robots leverages a range of platform-specific solutions, such as:

- **Amazon S3**
- **Azure Blob Storage**
- **Google Cloud Storage**

In terms of **data management**, the system supports both **SQL** and **NoSQL** databases:

- **SQL:** MySQL and PostgreSQL RDBMS systems used for structured, relational data
- **NoSQL:** MongoDB and DynamoDB (on AWS) support unstructured and semi-structured data

This multi-database architecture allows the company to **choose the best data storage model for each use case**, optimizing performance, scalability, and maintainability across different services and environments.

By maintaining this **cloud-agnostic approach**, Lumion Robots ensures its robotic software platform remains highly portable and scalable—ready to meet customer demands and infrastructure preferences in any region or market.

4.3 Networking and Security

Lumion Robots's networking and security architecture is built on a **defense-in-depth** approach, combining both cloud-based and on-premises measures to ensure system integrity and data protection.

In the cloud, **Virtual Private Cloud (VPC)** configurations are used to **isolate resources within logically segmented networks**, enhancing control over traffic flow and access permissions. **Load balancers** are employed to efficiently distribute incoming traffic across services, improving availability and performance.

At the company's headquarters, **firewalls** and **security groups** are used to manage internal and external network traffic, prevent unauthorized access, and enforce security policies.

To support remote work and secure access to internal systems, Lumion Robots utilizes **Virtual Private Network (VPN)** solutions, enabling encrypted connections for employees working off-site.

These combined measures ensure **secure communication**, **reliable system availability**, and **controlled access** across all operational environments.

4.4 Development Tools

Lumion Robots utilizes a diverse set of development tools to support agile and efficient software engineering. Developers are free to choose their preferred **Integrated Development Environments (IDEs)**, including **Visual Studio Code**, **JetBrains IntelliJ IDEA**, and **Eclipse**.

Version control is managed using **Git**, with repositories hosted on **GitLab**. The company has established automated **Continuous Integration and Continuous Deployment (CI/CD)** pipelines within GitLab to streamline testing, validation, and deployment processes. These pipelines help ensure that software releases are both reliable and frequent.

4.5 Data Management and Analytics

Data at Lumion Robots is structured to support both operational needs and strategic insights. The company uses a **hybrid data model** that includes:

- **Relational databases** such as **MySQL** and **PostgreSQL** for structured transactional data
- **NoSQL databases** such as **MongoDB** for unstructured or semi-structured data

For **large-scale data warehousing**, Lumion Robots utilizes **public cloud platforms** to ensure scalability and availability.

To gain real-time and historical insights, the company uses tools like **Elasticsearch** for search and indexing, and **Grafana** for visual analytics and dashboarding. This allows teams to derive **actionable insights** that inform both product performance and business decision-making.

4.6 Programming Languages

Lumion Robots uses a carefully selected set of programming languages to match the needs of embedded robotics development, cloud-based services, and full stack applications. The primary languages include:

- **C/C++** – for low-level firmware and real-time control on embedded systems
- **Python** – for scripting, automation, data analysis, and AI/ML components
- **Java** and **Kotlin** – for Android-based mobile applications
- **JavaScript / TypeScript** – for front-end development using frameworks such as React
- **Go (Golang)** – for performant cloud-native microservices
- **Rust** (*experimental*) – in selected modules where safety and memory efficiency are critical

This diverse language set enables Lumion Robots to optimize performance, scalability, maintainability, and developer productivity across its ecosystem.

4.7 Operating Systems

The company employs multiple operating systems tailored to specific use cases:

- **Linux (Ubuntu, Debian, Alpine)** – the primary operating system for cloud infrastructure, containers, and backend services
- **ROS (Robot Operating System) on Linux** – as the foundational framework for robotic software development and hardware abstraction
- **Android** – for companion mobile apps and potential integration into smart displays or user interfaces
- **RTOS (Real-Time Operating Systems)** such as **FreeRTOS** – used in embedded microcontrollers within robotic devices to guarantee real-time behavior
- **Windows** – supported for internal development environments and compatibility testing

This operating system strategy ensures flexibility across development and production environments, while maintaining robustness and predictability for both robotic systems and cloud-based platforms.

4.8 Cybersecurity Measures

Lumion Cybersecurity is a top priority at Lumion Robots. The company employs a **multi-layered security architecture**, including:

- **Firewalls and Intrusion Detection/Prevention Systems (IDS/IPS)** for network protection
- **Data encryption**, with **SSL/TLS** securing data in transit and **AES** used for encryption at rest
- **Multi-Factor Authentication (MFA)** to enhance user authentication
- **Identity and Access Management (IAM)** policies to control access to systems and data based on roles and responsibilities

These measures collectively ensure that sensitive data, development environments, and customer information are well-protected.

4.9 Monitoring and Management

To maintain high availability, performance, and observability across its infrastructure, Lumion Robots uses a comprehensive monitoring stack:

- **Nagios, Zabbix, and Prometheus** for system and service monitoring
- **ELK Stack (Elasticsearch, Logstash, Kibana)** for centralized logging and log analysis
- **Ansible** for automated configuration management and system provisioning

These tools help the company proactively detect and resolve issues, reduce downtime, and ensure consistent system behavior across environments.

4.10 Development and Testing Environments

To ensure robust and reliable software delivery, Lumion Robots maintains **segregated environments** for:

- **Development**
- **Testing**
- **Staging**
- **Production**

This separation enables controlled testing, quality assurance, and validation prior to live deployment, minimizing the risk of disruptions and enhancing product stability.

5 Product example: Lumion SnowMate

Lumion SnowMate™ is an advanced autonomous robotic snow blower designed to clear snow from driveways, walkways, and small roads with minimal human intervention. Combining rugged hardware with intelligent software, SnowMate adapts to different weather conditions and environments, ensuring safe and efficient snow removal for private households and small commercial properties.

Built with Lumion Robots's fullstack robotics platform, SnowMate integrates AI-driven path planning, obstacle avoidance, and adaptive power management. It is engineered for extreme conditions, providing reliable performance in temperatures as low as -30°C.

Device is based on

- **AGV** (Autonomous Ground Vehicle) platform solutions
- **ROS2** (Robot Operating System 2) robotics platform that supports real-time communication, sensor fusion and modular programming
- Tracked or **4WD** platforms: Adapted for outdoor use and harsh winter conditions

5.1 Key Technical Specifications

5.1.1 Hardware Features

- **Drive System:**
 - All-wheel drive (AWD) with rubberized tracks for enhanced traction on snow and ice
 - Independent suspension for uneven terrain
- **Clearing Mechanism:**
 - Dual-stage auger with adjustable chute angle (up to 200° rotation)
 - Snow clearing capacity: up to 25 cm depth and 60 cm width per pass
 - Throwing distance: up to 10 meters
- **Battery & Power:**
 - 60V lithium-ion battery (removable)

- Runtime: up to 2 hours per full charge
- Optional solar-assisted charging station
- **Sensors & Cameras:**
 - LIDAR, ultrasonic sensors, GPS module
 - Dual HD cameras (front and rear) for environment awareness
 - IMU (Inertial Measurement Unit) for orientation tracking
- **Frame & Build:**
 - Weatherproof housing (IP65)
 - Heated electronics enclosure and anti-icing features

5.1.2 Software Features

- **Navigation & Autonomy:**
 - Real-time SLAM (Simultaneous Localization and Mapping)
 - AI-based route optimization and path prediction
 - Geofencing for virtual boundaries
 - GNSS + RTK GPS: Precise outdoor mapping
- **User Interface:**
 - Mobile app (iOS & Android) for scheduling, remote control, and real-time monitoring
 - Web dashboard for advanced diagnostics and analytics
- **Cloud Integration:**
 - Data synced via Wi-Fi or 4G LTE
 - Secure OTA (Over-the-Air) updates and remote diagnostics
- **AI & ML Capabilities:**
 - Adaptive learning based on property layout and snow patterns
 - Predictive maintenance alerts
 - Dynamic adjustment of clearing power based on snow density

5.1.3 Key Benefits

- Fully autonomous operation with minimal human oversight
- Adaptable to changing snow and weather conditions
- Safer than manual snow removal, especially for elderly users
- Designed for Nordic winter environments
- Product Integrates into Lumion Robots's ecosystem and cloud environment.

References

Dennis, Giese. 2024. Reverse engineering and hacking Ecovacs robots. Defcon 32. Available at: https://dontvacuum.me/talks/DEFCON32/DEFCON32_reveng_hacking_ecovacs_robots.html

ROS - Robot Operating System <https://www.ros.org/>

FreeRTOS - <https://www.freertos.org/>

Appendices

Appendix 1. VLE infrastructure with Management Information

*Note: Not available for autumn 2025b implementation. However, similar environments are built on future courses such as Cyber Security Implementation in Practice.

NAME	IP	FQDN	ZONE	Public	Service	Primary usage	OS-TYPE	USERNAME	PASSWORD	HTTP	HTTPS	SSH	RDP	Telnet	App login	[user]	[password]
Firewall	10.99.0.100	fw.sahka.vle.fi	MGMT		Firewall	NG-firewall	PANOS	admin	Yamk-2022		X				HTTPS	admin	Yamk-2022
Firewall-ISP-net	198.18.5.2/30		INET		Firewall	Connection to VLE ISP (198.18.5.1)											
SIEM	10.99.0.10	siem.sahka.vle.fi	MGMT		ElasticSIEM	Log and Netflow data analysis	CentOS7	root	Yamk-2022	X	X				HTTPS		
Elasticsearch	10.99.0.11	elastic.sahka.vle.fi	MGMT		Elasticsearch	Elasticsearch storage node	CentOS7	root	Yamk-2022	X	X				HTTPS		
Dataanalytics	10.99.0.13	dataanalytics.sahka.vle.fi	MGMT		Grafana	Grafana server	CentOS7	root	Yamk-2022	X	X				HTTPS	admin	Yamk-2022
Fireeye	10.99.0.30	fireeye.sahka.vle.fi	MGMT		Fireeye EDR	EDR	Fireeye	admin	Yamk-2022	X	X				HTTPS (port 3000)	admin	Yamk-2022
PRTG	10.99.0.40	monitor.sahka.vle.fi	MGMT		PRTG	Centralize Service Monitoring	2012R2	Administrator	Yamk-2022	X	X		X		HTTPS	admin	Yamk-2022
ntp	10.10.10.2	ntp.sahka.vle.fi	DMZ	X	Chrony	NTP-server	CentOS7										
ns1	10.10.10.4	ns1.sahka.vle.fi	DMZ	X	Bind	Public creditbanken.de authoritative DNS	CentOS7	root	Yamk-2022			X					
ns2	10.10.10.8	ns2.sahka.vle.fi	DMZ	X	Bind	Public creditbanken.de authoritative DNS	CentOS7	root	Yamk-2022			X					
Extranet	10.10.10.10	extranet.sahka.vle.fi	DMZ	X	Wordpress	Extranet for partners	CentOS8	admin	Yamk-2022	X					/wp-login.php	admin	Yamk-2022
www	10.10.10.20	www.sahka.vle.fi	DMZ	X	Cyclos	Bank for customers	CentOS6	root	Yamk-2022	X	X	X			/do/login	admin	Yamk-2022
Mail	10.10.10.30	mail.sahka.vle.fi	DMZ	X	Postfix + Dovecot + Roundcubemail	Mail for users	CentOS7	root	Yamk-2022	X	X	X					
Helpdesk	10.10.10.40	helpdesk.sahka.vle.fi	DMZ	X	Zammad	Helpdesk for users	CentOS7	root	Yamk-2022		X	X					Yamk-2022
DMZ-public IP-block	198.19.1.0/24				Firewall	1-to-1 NAT public address pool for DMZ											
DC	10.0.100.10	dc.sahka.vle.fi	SRV		AD,DNS	Active directory and DNS-resolver	2012R2	Administrator	Yamk-2022				X				
Files	10.0.100.20	files.sahka.vle.fi	SRV		File sharing	File service for employees	2008R2	Administrator	Yamk-2022				X		As domain admin		
Intra	10.0.100.30	intra.sahka.vle.fi	SRV		Wordpress	Intranet for employees	CentOS8	root	Yamk-2022	X		X			/wp-login.php	admin	Yamk-2022
SQL	10.0.100.50	mysql.sahka.vle.fi	SRV		mysql	DB for the services	CentOS7	root	Yamk-2022			X			mysql	root	Yamk-2022
SimpleCA	10.0.100.60	ca.sahka.vle.fi	SRV		Custom	RootCA and Certificate services	CentOS7	root	Yamk-2022		X	X					
Proxy	10.0.100.70	proxy.sahka.vle.fi	SRV		Squid	Proxy server	CentOS7	root	Yamk-2022			X					
Gitlab	10.0.100.80	gitlab.sahka.vle.fi	SRV		Gitlab 16.3	Git version control	CentOS8	root	Yamk-2022		X	X				root	Yamk-2022
Dev-WS	10.0.110.0/24	dev-ws.sahka.vle.fi	DEV WS			Dev workstation	Windows 10	user	Yamk-2022				X				
MGMT-ws	10.100.0.0/24		MGMT WS				Student Kali	kali	root66								
Staff-remote-ws	198.18.102.132						Windows 10	user	Yamk-2022				X				