LINDSTRÖM GROUP
A REINVENTED WORKFLOW OPTIMIZATION SOLUTION ENABLED BY THINGSEE IoT PLATFORM AND WIREPAS MESH

ABIresearch
for visionaries

USE CASE BACKGROUND

Facility management is a vital component and service to any business and its buildings, with personnel routinely ensuring areas, including washrooms, are maintained at a high standard in hospitals, schools, and shopping malls. Cleaning staff frequently check whether there are enough cotton towels in hand towel dispensers, for example, resulting in staff walking up to 10 kilometers per day. In some facilities, dispensers become empty frequently, such as in restaurants located within major airports serving thousands of customers per day.

As part of its FlowAbility service, the Lindström Group, a leading Finnish multinational B2B textile services provider, decided to implement an IoT solution to improve customer experience and improve personnel workflow. The company has 170 years of experience in the textile industry, operating in 24 countries in Europe and Asia with approximately 200,000 customers. The Lindström Group provides rental of textiles, such as workwear and mats, along with washroom services for customers in a number of industries including retail, government, and healthcare.

The Lindström Group was primarily looking at the benefits for the end customers and partners. By monitoring the fill level of hand towel dispensers, this goal can be achieved. The main objective was to enable cleaning personnel to refill dispensers in advance and ensure that customers never run out of towels, with the secondary benefit of allowing service requests to be made *via* a mobile application if a dispenser requires maintenance.

The primary solution requirements were cost effectiveness, in order to provide a scalable hygiene service for both small and large customers in Finland and their subsidiaries abroad. This is especially important considering the Lindström Group currently has more than 100,000 hand towel dispensers in Finland alone, equating to over 3 million roll changes per annum. Key performance indicators for such a system are service volumes for both current and new customers, and customer feedback of the new service.

The Lindström Group chose to deploy a hardware and software platform called Thingsee, developed by Haltian. Wirepas Mesh was also chosen to provide reliable coverage for the Lindström Group across its facilities. The solution offers bi-directional communication and location information in combination with Haltian's Thingsee platform.The Lindström Group initiated the project in January 2017, with the request for quotation (RFQ) phase taking around two-and-a-half months, with the business case approved in March. The product concept was ready in April, followed by solution testing in June, and a deployment plan was ready in November of the same year. After launch plans were approved in January 2018, more than 2,000 devices are now currently connected, distributed between 20 customers, with plans to roll out the system to the Lindström Group's 200 largest customers. The solution has been deployed in the public sector, including hospitals and schools, and the Lindström Group is working closely with facility management companies for deployments in industry.The system is now being used by the Lindström Group's customer base as part of its FlowAbility Washroom solution, currently offered in Finland and being piloted in Lithuania. The Lindström Group expects rollouts in other countries in the short-term future.

The FlowAbility Washroom solution will enable the Lindström Group to achieve its strategic goal of improving customer experience through digital solutions and smart technology, allowing facility managers and cleaning personnel to stay informed about washroom status. FlowAbility Washroom is an evolution from the Lindström Group's Smart Washroom 1.0 system, first implemented in 2016.

THE ADOPTION OF MESH NETWORKING AND WIREPAS MESH

Asset and inventory management via real-time location systems (RTLS) has been in operation since the early 1990s, when radio frequency identification (RFID) was used in the healthcare industry in the United States. Since then, technologies have evolved alongside the increasing appeal and maturity of industrial-grade IoT, and new technologies with functionalities beyond RFID have now come to the forefront. Companies are increasingly looking for systems that go beyond providing high-level information to facility managers and that can leverage connectivity in handsets to allow real-time notifications to personnel on the ground.

In order to meet the requirements set out for the project, the Lindström Group had a choice between using cellular connectivity for gateway devices in combination with short-range radio technology to create a mesh network for the sensors, or using a star topology using a long-range radio protocol, such as LoRaWAN.

Mesh networking uses low-power radio technology to connect enabled devices to the network. It creates large-scale device networks using automatic multi-hop routing for transmitting messages that is simple,

reliable, and suited for low-power wireless networks handling large amounts of diverse traffic. This technology is currently being used in industrial settings to control the large-scale physical environment. Current use cases include building automation, wireless sensor networks, and asset tracking.

By using a mesh networking protocol in combination with ultra-low power BLE hardware for sensor-to-gateway communication, a network topology can be implemented that facilitates longer range and scalability between sensor devices and gateway devices. The ability to use a decentralized network topology also reduces power consumption, meeting the goal of life-time cost optimization.

The Lindström Group evaluated different options and opted for Wirepas Mesh. Although the rollout of these devices is still underway and only some of the expected advantages have been realized, so far, key benefits and reasons for using Wirepas Mesh include:

- **Ease of Installation and Configuration**: Less system configuration is required as additional nodes can be freely deployed between sensors, reducing the need for new gateways. Sensor clusters can be linked together with additional intermediate nodes. Gateways are also easily added on-site, reducing the amount of planning and configuration due to automatic routing features. The customer is able to easily see from the Installation Support Cloud that everything is running as intended. This self-configuration reduces the installation time compared with other approaches that the Lindstrom Group considered during the RFQ phase that require network management configuration overhead. Bypassing this stage adds benefits in terms of installation ease and duration.

- **Adaptability**: Additional functionalities may be implemented to the FlowAbility service, including detecting when people are in the washroom. New functionalities often require different and additional sensors. The network allows easy integration of other services and is future proof for expansion to other sensor types, resulting in additional data pushed to the cloud, further enriching the customer benefits. This results in fast implementation, should the Lindstrom Group want to implement a full indoor positioning system, for example.

- **Infrastructure Cost Optimization**: Due to the adoption of Thingsee technology and Wirepas Mesh, the amount of gateway devices required is minimal, making mesh networking ideal for this purpose. There are usually numerous washroom facilities in a typical building; however, the amount of infrastructure to cover them has been achieved using fewer gateways. Typically, one gateway device for between 20 and 30 sensor devices is used, leaving significant headroom as the capacity is still tenfold.
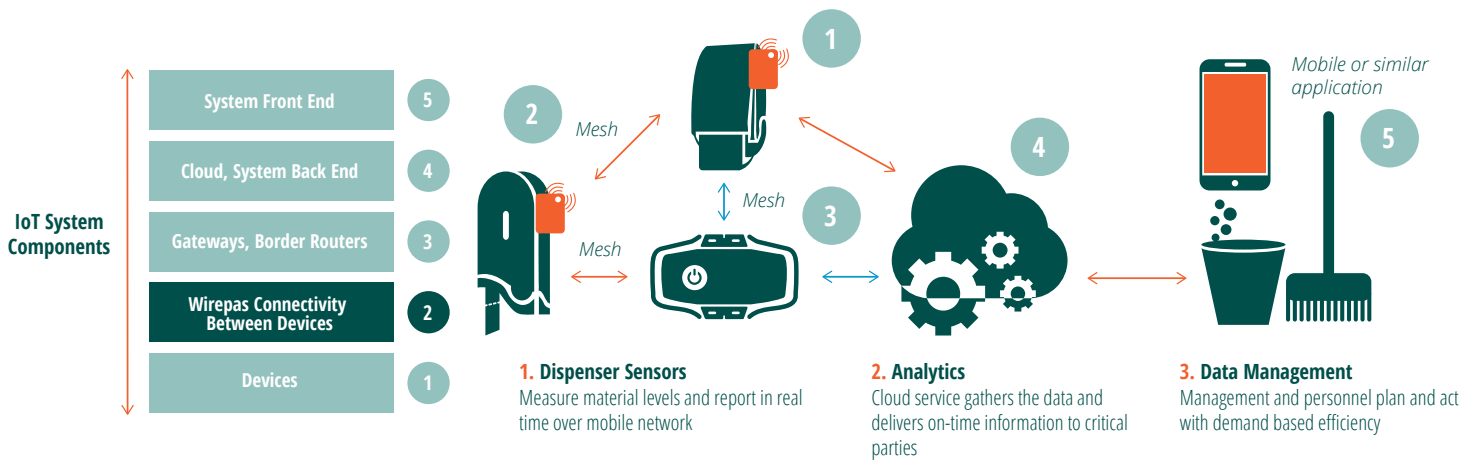
  One challenge in customer facilities, such as offices, is having multiple clusters of washrooms located on each floor of the building. This forms a difficult physical topology of dense clusters, which are sparsely spread throughout a building and typically made of RF opaque materials like concrete and metal. If traditional architectures using competing technologies are used, then gateways must be installed next to washrooms and the gateway/sensor ratio typically increases to one gateway for every five sensors.During testing at the Lindström Group's headquarters with 50 sensor devices, 3 gateway devices were initially installed in the first, third, and fifth floors. After stress testing, it was discovered that

only one gateway was needed for whole-building coverage. Results like these depend on the physical topology of the building, but Wirepas Mesh can, provided devices are within radio range, achieve better ratios, thereby reducing the total cost of ownership (TCO) of the solution.

- **Power Consumption**: One of the issues with alternative mesh technologies is power consumption, meaning batteries need to be replaced often, adding to the cost and complexity. Due to Thingsee devices being battery powered, a system with low-power consumption as a core performance-related characteristic was required.

OPERATIONAL DESCRIPTION

The concept behind the Lindström Group's FlowAbility Washroom is the enablement of hand towel dispensers with sensors to measure the distance between the dispenser and hand towels. As the quantity of hand towels decreases, the distance subsequently increases. After the distance increases beyond a specified level, real-time notifications and data are simultaneously sent to the cloud and cleaning personnel. Cleaning personnel are able to note which specific dispenser at the customer's premise is running out of towels and refill it. This operation is summarized in Figure 1 below.

IoT System Components

System Front End	5
Cloud, System Back End	4
Gateways, Border Routers	3
Wirepas Connectivity Between Devices	2
Devices	1

1. Dispenser Sensors
Measure material levels and report in real time over mobile network

2. Analytics
Cloud service gathers the data and delivers on-time information to critical parties

3. Data Management
Management and personnel plan and act with demand based efficiency

The system's core consists of the Thingsee IoT Devices Platform, which connects all devices to a Lindström-specific system back-end for analytics and application enablement. The Thingsee IoT Devices Platform consists of Thingsee sensor devices, Thingsee gateway devices, and the Thingsee Operations Cloud that takes care of device-related services like installation, provisioning, software updates, and more as a managed service. Additionally, the platform enables various device-related services, such as installation tools.

The sensor devices communicate with the gateways using commodity Bluetooth Low Energy hardware accompanied by Wirepas Mesh protocol, keeping power consumption to a minimum. Gateway devices then communicate over cellular networks for the collection and management of the data from the sensors to the Thingsee Operations Cloud, and finally to the Lindström system's back-end and the notification push to handsets in the facility.

The Lindström Group wanted a solution using bespoke hardware, giving it more flexibility, particularly regarding the sensor types. This comes as no surprise, as customers of industrial IoT solutions have increasingly found that if the correct fit-for-purpose hardware is combined with the correct software solution, the desired outcome is easier to achieve.The sensor devices are battery powered, meaning that energy efficiency is a primary concern on a *per device basis*, unlike IoT devices like smart electricity meters. When looking at the total power budget for the entire communications system, including gateways, total energy consumption levels can vary significantly for different communications technologies. Gateway location is also a critical aspect, and the density of their distribution can be a challenge for communication networks.

Haltian's business model allows customers to specify custom sensor offerings as part of Thingsee and, ultimately, the Lindstrom Group has opted to use infrared time-of-flight sensor distance sensors as part of its custom Thingsee hardware solution. Haltian noticed that the device prices in the previous iteration of Thingsee (Thingsee One) were too high, and that individual sensor costs must be significantly lowered to go out at high volumes and enable commercial operations. This led to Haltian developing a completely new hardware generation and a new device management services (Thingsee Operations Cloud) offering for the next iteration of Thingsee, with devices costing in the lower tens of Euros.

The Thingsee offering not only includes sensor hardware, but it also includes device connectivity and management to enable updates as required. Creating a complete and well performing IoT data layer requires tight integration devices and device services. Therefore, Haltian prefers a sensors-as-a-service model.

To enable cost-efficient industrial IoT solutions, Haltian formed a strategic partnership with Wirepas, allowing it to start building large-scale solutions for its customers, with high performance enabled by the Wirepas Mesh offering. In this case, mesh networking also lowers the amount of individual gateway devices required, complementing the cost of the total offering.

The Lindström Group went through an extensive review before selecting the combined Thingsee and Wirepas Mesh solution. According to the Lindström Group, Haltian's proposal was technically superior and, most importantly, was considered an economically competitive solution. The solution was found to be designed for the future and would provide the Lindström Group with the requested customer experience functionalities as laid out in the proposal. The wireless communication platform also meets the need for flexibility and performance required for future developments.

CELLULAR CONNECTIVITY COMPLEMENTS WIREPAS MESH

High-volume inventory management across multiple facilities and customers requires long range, scalability, and optimization of life-time costs. The selection of the right communications technology to meet both current and future demand is fundamental to the success of inventory management operations. In the Lindstrom Group's case, the infrastructure is required to remain in operation for a minimum of 10 years, so selecting future-proof technologies with reasonable TCO, as well as the related suppliers, is critical.
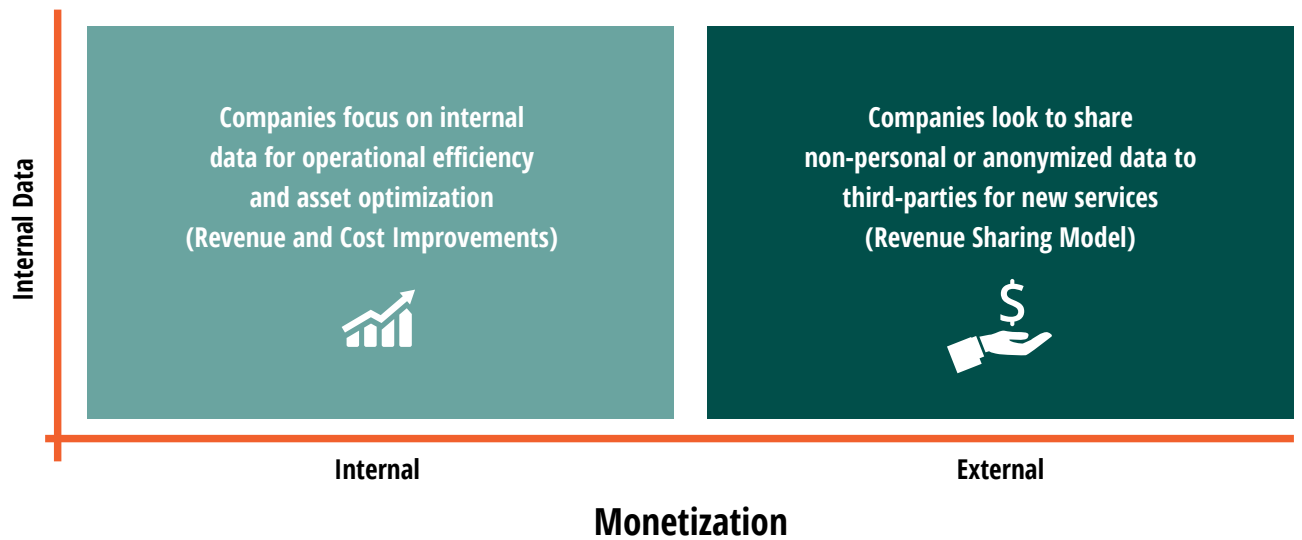
The Lindström Group invited a number of companies to propose architectures for the project and evaluated the different offers during the RFQ phase. Both LoRaWAN and 3GPP-standardized cellular networks were considered and evaluated to handle gateway data communication to the cloud. The Lindström Group was looking for a reliable and long-range solution that would work in every corner of Finland, as well as globally. It quickly became obvious that only one technology was able to provide the required performance.In many ways, Wirepas Mesh and licensed cellular connectivity are complementary. Both have the following characteristics:

- **Scale, Coverage, and Density:** Both technologies can cover large geographical areas and connect a large number of devices.

- **High Reliability and Availability:** For high bandwidth backhaul connectivity, licensed cellular connectivity provides higher reliability and risk minimization in compared to using unlicensed networks. Wirepas provides self-healing and interface avoidance methods to increase reliability.

- **Future Proof:** Over-the-air-programming (OTAP) is provided with Wirepas Mesh and IoT-focused licensed cellular networks will soon be available.

The cost of alternative solutions was also assessed. Considering the network topology, the location of the gateways, the frequency of data collection from the sensors, and the overall system performance, the final decision was to adopt cellular communication from the gateways to the cloud. This is complemented by using the Wirepas Mesh protocol for the sensors to the gateways, resulting in a connectivity technology that could complement a highly-scalable hardware offering, and connect a large number of devices at a competitive overall cost.Using cellular networks will also allow an upgrade to low-power technology standards, such as NB-IoT and LTE Cat-M, as the pricing plans for these decrease. Besides low-power consumption, these technologies will have other advantageous characteristics, such as increased signal penetration, allowing gateway devices in challenging environments or rural environments to provide better connectivity.

DATA MONETIZATION AND ANALYTICS

The monetization of data assets has become a huge area of opportunity for enterprises. The challenge is how to achieve internal monetization. Enterprises have, for the most part, experience and capabilities in applying internal data for internal improvement and monetization purposes. Here, technology can assist enterprises with internal monetization of data through analytical tools. Figure 2 below shows the two types of monetization that can be achieved with internal data obtained from using IoT platforms like Thingsee.

	Companies focus on internal data for operational efficiency and asset optimization (Revenue and Cost Improvements)	Companies look to share non-personal or anonymized data to third-parties for new services (Revenue Sharing Model)

Internal Data (vertical axis label)

Internal | External

Monetization

The Lindström Group obtains a huge amount of data from all of its customers in terms of how they are changing dispensers. For example, after implementing this system, the Lindström Group has found that the walking distance reduced by over 20%, walking 2.3 kilometers less on average, and cleaners can spend this time saved cleaning nearby areas.

This data from Thingsee can be used to create online data reporting and promote value-added reporting services for premium customers. Much of the costs in the cleaning industry are human related and the employees planning these cleaning services need to obtain data about how and where the business is spending its efforts. Customers also gain insight about how many people visit these washrooms. They can figure out how to improve cleaning and maintenance operations. Partners are able to integrate these APIs from Azure to their systems if necessary.

For enterprises like the Lindstrom Group, data monetization reveals a series of new developments, services, and, ultimately, revenue opportunities.

About ABI Research

ABI Research provides strategic guidance for visionaries needing market foresight on the most compelling transformative technologies, which reshape workforces, identify holes in a market, create new business models and drive new revenue streams. ABI's own research visionaries take stances early on those technologies, publishing groundbreaking studies often years ahead of other technology advisory firms. ABI analysts deliver their conclusions and recommendations in easily and quickly absorbed formats to ensure proper context. Our analysts strategically guide visionaries to take action now and inspire their business to realize a bigger picture. For more information about ABI Research's forecasting, consulting and teardown services, visionaries can contact us at +1.516.624.2500 in the Americas, +44.203.326.0140 in Europe, +65.6592.0290 in Asia-Pacific or visit www.abiresearch.com.