Lift IoT: Turning Sensor Data into Value

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Abstract. When companies talk about IoT – the "Internet of Things", which typically refers to a system or device with sensors, a network for transmitting data, and a system that can process and trigger actions, it is today far more than just an industry buzzword. IoT is a critical part of turning data into value that can lead to improvement in operational efficiencies, reduced maintenance costs, and even real-time system adaptations for improved system performance. Most importantly, data is at the heart of any IoT product.

1 INTRODUCTION

In today's lift systems, there are already plenty of sensors installed for various functions, however, the full potential of the data out of these sensors is by far not yet exploited. Sensor data can be turned into useful information for lift companies, as well as for real estate owners and facility managers. IoT and data-driven predictive maintenance can dramatically enhance the lift companies' efficiency. Real scenarios and the real benefits will be explored.

2 UNLOCKING THE POWER OF DATA IN LIFT SENSORS

Various sensing devices built into modern lift installations, from simple light curtains to complex time-of-flight sensors, are already capable of collecting a large amount of data. This section provides specific examples with corresponding data types that could be derived and integrated into an IoT solution.

2.1 Absolute positioning system and safety supervision

The combination of an absolute positioning system and the new generation of powerful EN 81-20/50-compliant safety supervision unit is capable of providing a large amount of valuable data. The car position and velocity are being continuously monitored. At any moment, it is known whether the car is travelling or stationary. Of course, the exact car position in [mm] in the shaft is known; from it, the car's speed [m/s] and acceleration [m/s^2] can be easily calculated. Furthermore, the configuration of the lift can be extrapolated, providing information on the number of floors and the distance between them [see Fig. 1].

More interestingly still, statistical usage data can be derived, including:

- total trip counter,
- number of trips per floor,
- total travelled distance.

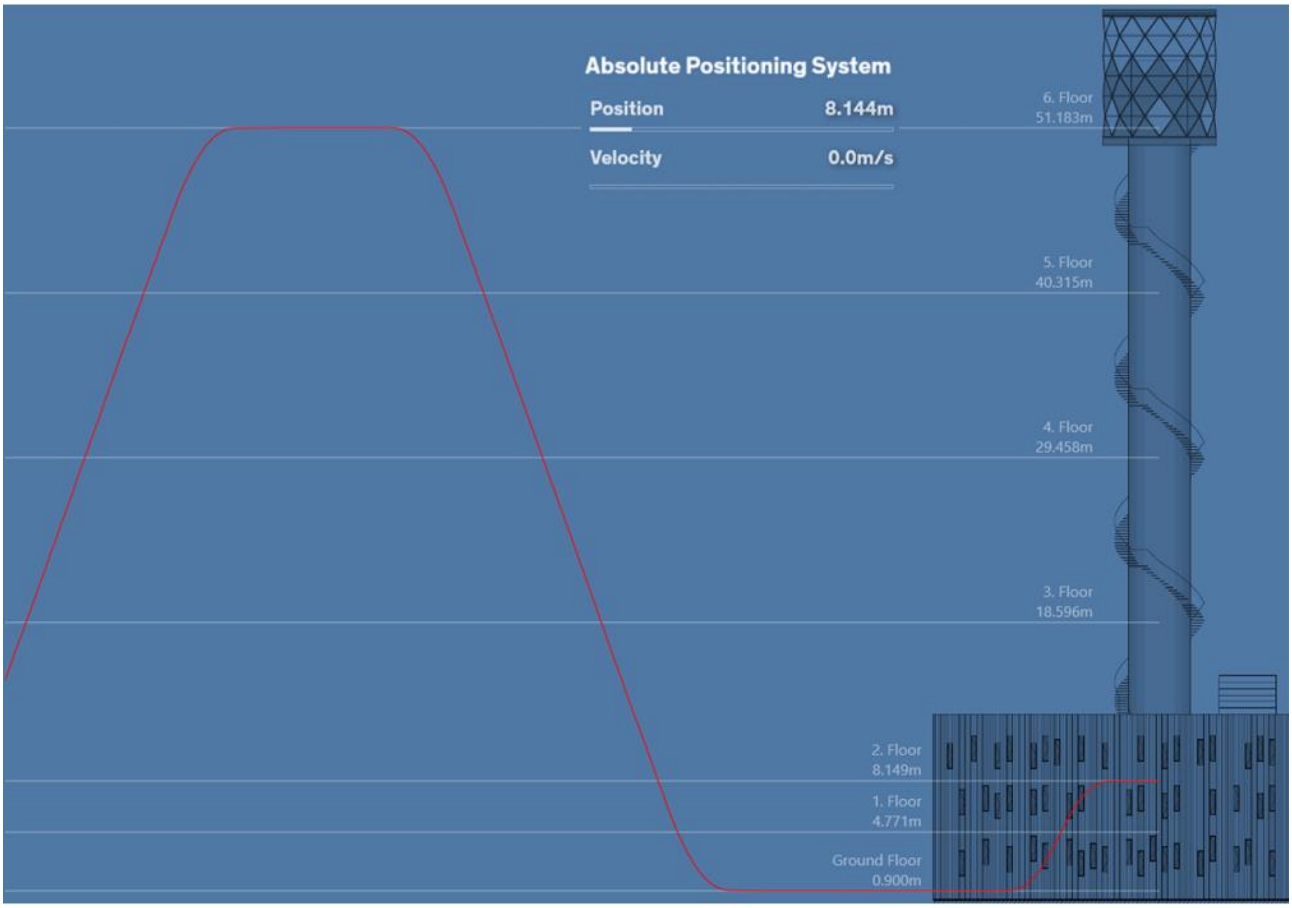

Figure 1 Current lift position, velocity and trip pattern in a six-floor tower

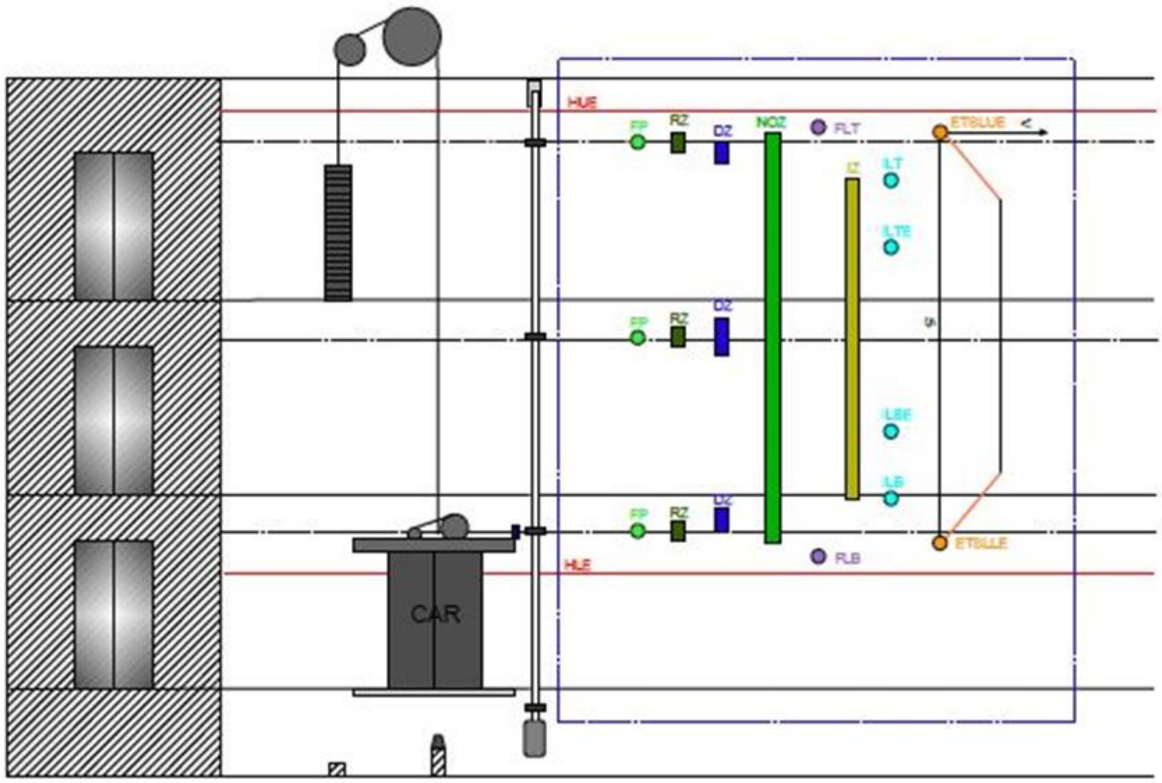

Figure 2 Shaft definition of a 3-floor lift representing different car position zones

The safety supervision unit monitors several additional data points pertaining to the car position [Fig. 2] and the lift status, as listed below and visualized in Fig. 3.

Car position:

- leveling, re-leveling zone
- final limit switches (ON/OFF)
- inspection limit switches (ON/OFF)
- extended inspection limit switches (ON/OFF)

Door:

- door status (OPEN / CLOSE)
- door contacts monitoring (faulty / bridged)

Safety:

- Safety chain status (OPEN / CLOSE)
- Overspeed detection
- Detection of unintended car movement (UCM)
- Safety gear monitoring status (ON/OFF)

Other:

- Car inspection operation status (ON/OFF)
- Pit inspection operation status (ON/OFF)
- Car door roof status (OPEN / CLOSE)
- Pit door status (OPEN / CLOSE)

Figure 3 Current lift position, velocity, trip pattern, incl. trip status [travelling upwards] and additional status information of a 3-floor lift

2.2 Door safety edge device

The 2019 North American Elevator Safety Code (ANSI A17.1-2019 / CSA B44-19) defines new requirements for the means of detecting persons or objects between the doors (2D) or approaching the elevator (3D). A 2D light curtain combined with a 3D TOF sensor and a controller can fulfil all these code requirements [Fig. 4 and 5].

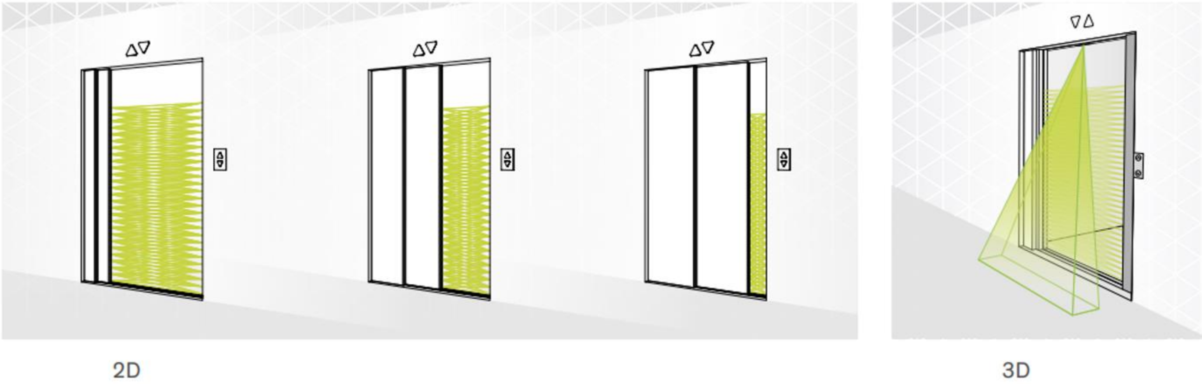

Figure 4 2D light curtain combined with a 3D ToF sensor

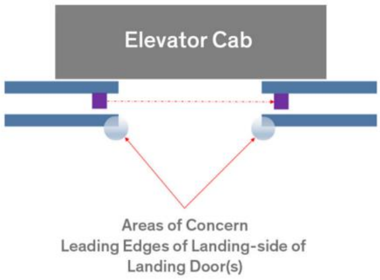

Figure 5 The detection areas of the system elements represented by red lines

Even a standalone light curtain collects valuable data that can be unlocked, such as the information that an object or person has been detected between the lift doors, as well as the number of such occurrences, i.e. counting people and objects leaving or entering the car. By combining it with a 3D sensor, further useful datasets can be derived.

People or objects in front of the cabin can be detected using ToF sensor technology. The technology makes it possible to distinguish between an object and a person, and to determine whether they are moving or stationary [Fig. 6].

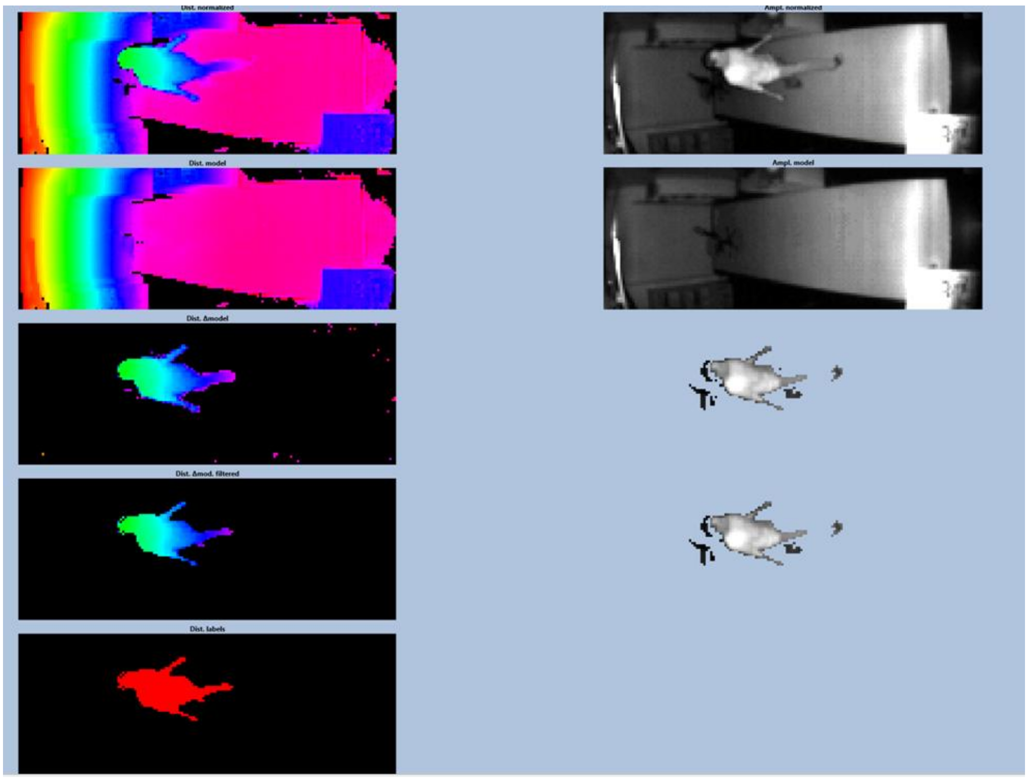

Figure 6 People or object detection using ToF and image processing technology

Not only the lobby area, but also the door itself can be monitored with ToF sensor technology and visualized as a greyscale image or an image providing distance information [Fig. 7].

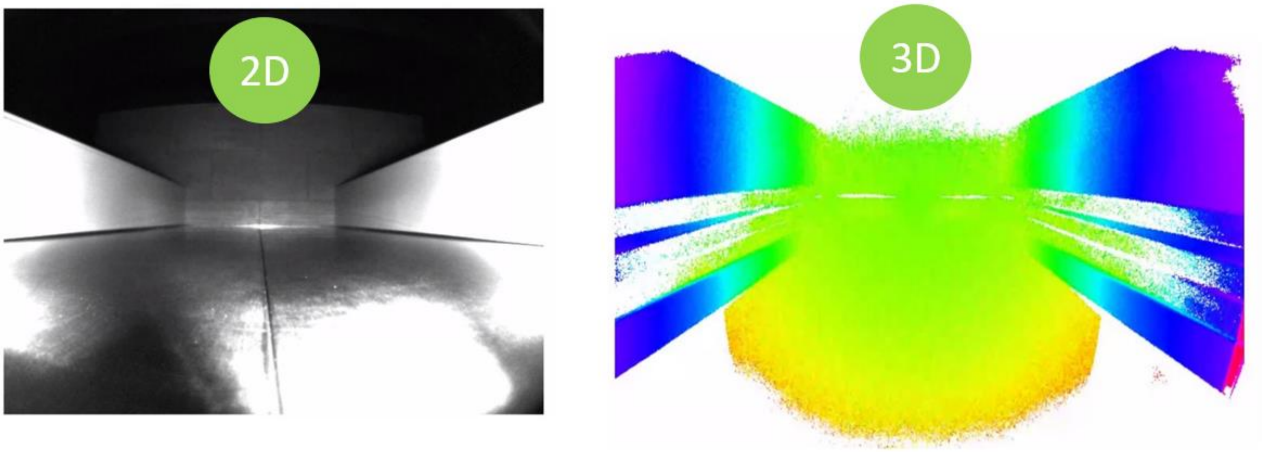

Figure 7 2D and 3D images of the door, the right one providing distance information

From this system, statistical usage data could be derived [as shown in the example dashboard in Fig. 8], including:

- Number of people and objects detected in front of the open doors and between the doors
- Door status (OPEN / CLOSE)
- Number of door cycles
- Number of door reversing
- Door opening and closing time

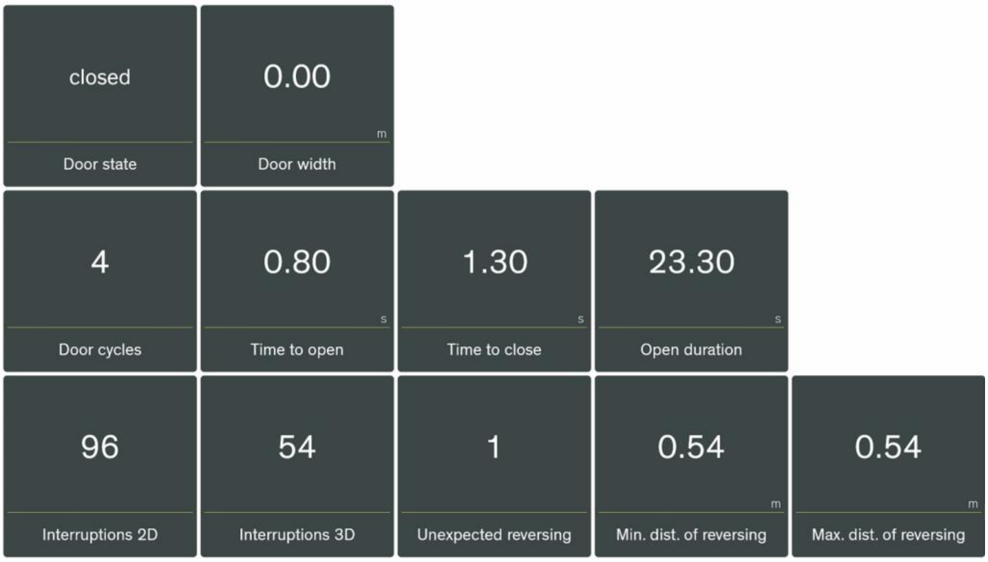

Figure 8 Example of a door statistic dashboard

3 IOT BENEFITS FOR LIFT COMPANIES AND THEIR CUSTOMERS

Inefficient maintenance processes, lack of data transparency, a large variety of lift types managed within one portfolio – the lift companies and their customers face a number of challenges in today's highly competitive lift aftermarket. IoT-enabled sensor solutions provide an answer to those challenges, paving the way towards data-driven maintenance.

3.1 Lift companies

The current maintenance model is time-based and consists of periodical checks at pre-defined intervals, as well as ad hoc repairs in case of breakdowns. It often happens that a single visit is not enough to eliminate a failure, due to scarce information on the possible root cause, lack of appropriate tools, spare parts, or trained personnel on site. Although going away from this traditional model is not yet in sight, access to relevant data would allow us to optimize it in a significant way.

Thanks to 24/7 condition monitoring and traffic analysis, it is possible to adapt the intervals between maintenance visits to the lift's actual wear and tear. Instead of working through fixed maintenance checklists, the lift company can put focus on repairs that are actually needed. More importantly, early detection of anomalies helps prevent complete breakdowns and thus reduce the number of unplanned maintenance visits in the long term. Based on root cause diagnostics, technicians are able to find and eliminate the error much faster, significantly reducing lift downtime. Based on data visualized in dashboards, the right team equipped with the right tools and the right parts can be allocated to a particular lift, and the visits can be prioritized based on failure severity. The same tool could also integrate troubleshooting instructions, allowing technicians to work in an even more efficient manner. It would mean a step away from reactive and towards proactive, predictive maintenance.

Another important benefit at hand is the possibility to collect data from all the installations in a portfolio, regardless of the lift types or models. IoT-enabled devices are easy to install in any type of lift and thus offer big advantages in simple modernization applications – connectivity is not limited to new installations. An overview of all lifts can then be visualized in a shareable dashboard, instantly showing warnings and red flags where anomalies or serious failures have been detected [Fig. 9]. This information can be accessed from any connected device and made available to all the interested parties, such as facility managers, building owners or even end users.

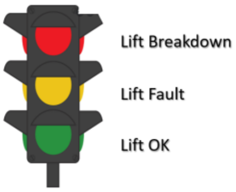

Figure 9 Lift status

Considering all the above, IoT solutions provide lift companies with a competitive edge in the increasingly connected and digitalized world and are becoming an important factor in driving business value. More and more companies are shifting from a product-first approach and reinventing their business models based on real-time data and connectivity [1, 2]. Access to data and increased maintenance efficiency constitute major added value for customers and foster their willingness to pay for a superior service experience. With the IoT in the lift market estimated to be worth $2Bn by 2028 [3], jumping on the IoT train can provide new sources of income and boost profitability.

3.2 Building owners and facility managers

The crucial change brought about by an IoT solution is data transparency. Lift companies can not only monitor the condition of their installations in real time, but also make this information available to relevant stakeholders. Visualized in shareable dashboards, the lift data becomes the basis for informed decisions and an important element of smart building ecosystems. As an example, people-counting and traffic analysis can contribute to better people flow management and to increasing the overall energy efficiency of a building.

Obviously, facility managers and building owners benefit from enhanced maintenance efficiency. Fewer faults and faster repairs result in reduced maintenance costs and higher lift availability, which in turn leads to higher satisfaction of the tenants and visitors. While the comfort of passengers is an important aspect, increasing passenger safety is the ultimate benefit of IoT-enabled sensor solutions - automatic notifications about a blocked lift with people trapped inside being just one example.

4 CONCLUSION

As illustrated by the examples of absolute positioning systems, safety supervisor units, time-of-flight sensors, and even light curtains, many elements of modern lift installations are already capable of collecting valuable data. IoT technology, in combination with machine learning and autonomous decision-making technologies, provide the key to unlocking the existing potential, bringing essential benefits to lift companies as well as their customers.

Although there are currently various types of IoT solutions for industrial use, the convergence of these multiple technologies, including sensors, connectivity, increasingly powerful embedded systems, and machine learning, is still ongoing. A challenge for the implementation of these IoT systems is the technological fragmentation.

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BIOGRAPHICAL DETAILS

Michele Guidotti – graduate of ETH Zürich and the MIT Sloan School of Management, an IoT expert with extensive experience in the lift industry (Schindler Group), currently Senior Product Manager at CEDES working on an IoT business case.