

SOTL

System of Things Learning

A Technical White Paper for Predictive Monitoring of Vertical Transportation and
In-Motion Equipment

Elevators • Escalators • Airport Baggage Handling • Other In-Motion Equipment

1. System of Things Learning

From equipment movement to actionable operational knowledge

SOTL—System of Things Learning—is presented as an end-to-end monitoring platform that connects what happens on an elevator car with the people responsible for operating, servicing, and funding that equipment. The core concept is straightforward: capture operating behavior where the equipment moves, process the information at the edge, securely move the resulting information to the cloud, and turn that information into reports that can support decisions.

SOTL is one pipeline from the car to the people responsible for it. Every SOTL5mini, SOTL5, and SOTL6 unit is an endpoint of that system. This is important because SOTL is not simply a sensor attached to an elevator. The sensor or monitoring device is one part of a larger architecture that includes edge software, device identity, fleet management, analytics, and reporting.

SOTL begins with operating data. The system can capture car runs, door cycles, incomplete cycles, releveing, vibration, and motion signatures. Rather than relying only on a generic alarm or a single fixed threshold, SOTL Analytics is described as learning the behavior of the individual car. A slow door, for example, is evaluated against that door's own baseline. This creates a monitoring model centered on the equipment's actual operating history.

The architecture is designed around the realities of vertical transportation equipment. Power loss and temporary network interruptions are treated as normal field conditions rather than exceptional failures. The SOTL Gateway keeps motion data through network and power loss and then catches up. The result is intended to be a monitoring system that continues collecting useful information even when communications are temporarily unavailable.

Security is also incorporated into the operating model. Each field unit has its own cryptographic identity, and the cloud communicates with Datahoist-issued devices. The system specifies outbound-only communication, eliminating the need to open inbound ports on a building network. Units can operate through cellular service or building Wi-Fi and run Datahoist-signed software.

The business value of System of Things Learning is therefore not the data itself. The value is the progression from raw movement to evidence. Building owners can see a building-level overview and longer-term trends, while service organizations can see the diagnostic information beneath the owner view. The same underlying evidence can support different levels of decision-making without requiring separate monitoring systems.

For elevators and other in-motion equipment, this creates a foundation for a more evidence-based maintenance process. Instead of asking only whether a unit is currently operating, SOTL is designed to answer what the unit has been doing, how that behavior compares with its own baseline, whether the condition is changing, and where attention may be justified.

2. How SOTL Works

A five-stage pipeline: Sense, Gateway, Link, Fleet, and Learn

SOTL works as a continuous information pipeline. The pipeline is organized into five stages: Sense, Gateway, Link, Fleet, and Learn. Each stage has a specific job, but the strength of the architecture is the connection between them. Data captured on the equipment becomes managed fleet information and ultimately becomes a report that a human can act upon.

The first stage is Sense. Sensors are installed where the equipment moves and capture operating characteristics such as door cycles, car runs, vibration, and motion class. For elevator applications, this places the monitoring point directly on the car rather than relying solely on information available from a controller or from a remote building system.

The second stage is Gateway. SOTL Gateway is the edge runtime—the software operating on the car. Power loss is a normal event and that the system is designed to preserve motion data through network and power interruptions. It reduces motion and vibration information on the unit so the cloud receives useful events and summaries rather than an unnecessary stream of raw information. Gateway can also update itself and attached sensor firmware without a site visit.

The third stage is Link. Each SOTL unit has an issued cryptographic identity. The cloud communicates with Datahoist-issued devices, and the field equipment calls out rather than requiring inbound access. This outbound-only design allows the system to operate behind building firewalls and carrier networks without creating an inbound network opening for each monitored device.

The fourth stage is Fleet. SOTL Device Management provides a live fleet view and tracks the desired versus actual state of devices. It also supports updates and diagnostics. Factory-enrolled units appear in the fleet on first power-up at the site, and SOTL supports an audit trail for configuration changes. This provides the operational control layer between individual hardware units and the people managing a portfolio.

The fifth stage is Learn. SOTL Analytics establishes the individual equipment baseline and evaluates trends against that baseline. It looks at door open versus close behavior, run versus relevel behavior, incomplete cycles, and expected use versus actual duty. A weekly trend engine supports fleet reporting, while owner and servicer views expose different levels of diagnostic depth.

The resulting workflow is designed to move the organization away from simply collecting equipment data and toward using that data as operational evidence. A building owner can ask which units need attention. A service organization can investigate the underlying trend. Management can review six-month and twelve-month behavior when considering maintenance, budgeting, or modernization.

- Sense: capture movement and equipment behavior at the equipment.
- Gateway: analyze and store information at the edge.
- Link: securely communicate using an issued device identity.
- Fleet: manage units, configurations, updates, and diagnostics.
- Learn: establish baselines, identify trends, and produce reports.

3. Inside SOTL

Three named layers connect field equipment, fleet management, and analytics

The SOTL architecture is organized into three named layers: SOTL Device Management, SOTL Gateway, and SOTL Analytics. These serve different roles while sharing the same underlying system. Building owners see the reports, while service companies and operators see the fleet and the diagnostic information beneath those reports.

SOTL Device Management is the cloud record for every unit. It records whether a device is online or offline, whether the equipment is in service or out of service, and the device configuration with an audit trail. Factory-enrolled units are intended to appear in the fleet on first power-up at the site. Sensors attach themselves to the corresponding car record, creating a relationship between the physical monitoring hardware and the logical equipment record.

Device Management also provides controls intended for reliable field deployment. Production, training, and diagnostic modes are separated so that temporary laboratory experiments expire rather than leaking into the production fleet. Updates, reboots, and diagnostics can be performed on units that have no inbound ports. This is a significant part of the system design because it reduces the need to physically visit equipment merely to perform routine device-management functions.

SOTL Gateway is the edge layer. It is the software on the car and is responsible for working with field data under real operating conditions. It retains motion information through network and power loss, then catches up when communication is restored. The Gateway also reduces motion and vibration information on the unit so the cloud can focus on events and summaries. Its ability to update itself and attached sensor firmware is intended to reduce dependence on site visits.

SOTL Analytics is the learning layer. Its central principle is that each car should be understood according to its own operating history. SOTL explicitly frames this as a unit-specific baseline rather than a generic threshold. Analytics can distinguish door open from door close, run from relevel, and complete from incomplete cycles. It can also compare expected use with actual duty and provide a weekly trend engine for fleet reporting.

The three layers create a progression from device state to operational understanding. Device Management answers whether the unit is connected and properly configured. Gateway handles what happens at the equipment. Analytics interprets operating behavior. Together, these layers provide the infrastructure required to support a monitoring program across multiple buildings and equipment types.

For service organizations, the architecture also creates a common operational record. The serial number on the physical box matches the fleet record. This helps connect what a technician sees in the field with what the organization sees in its management system. For owners, the result is a reporting layer that can summarize fleet conditions without requiring them to interpret raw sensor data.

4. SOTL5mini

A compact, door-mounted SOTL unit for elevator cars

SOTL5mini is the compact SOTL monitoring unit, it is designed for installation on the elevator car door and runs on the same SOTL platform as the rest of the fleet. The approach is intended to provide a practical monitoring path for existing elevator equipment without requiring the monitoring system to become a new building-network project.

The unit measures several categories of elevator behavior: car runs in the up and down directions, door cycles in the open and close directions, incomplete cycles, releveling, vibration, and motion signatures. These measurements provide the raw operating evidence used by the SOTL Gateway and SOTL Analytics layers.

The system specifies a door-mounted installation while power is supplied at 110 VAC from the car top and routed with the door travel cables. Network connectivity can be provided through cellular service or building Wi-Fi. The communication design is outbound-only, allowing the unit to work behind building and carrier networks.

Each SOTL5mini carries a serial-numbered identity using an S5M- prefix and is enrolled before shipment. This pre-enrollment supports the fleet-management model. When a factory-enrolled unit powers up at the site, it can appear in the fleet record without requiring an IT administrator to create a new inbound network rule.

SOTL5mini is positioned as a compact endpoint of the larger SOTL platform rather than as a stand-alone sensor. The same platform provides device management, edge processing, analytics, fleet visibility, and reporting. This means the hardware is only one part of the deployment. Once installed, the unit becomes part of a managed fleet in which its operating data contributes to an equipment-specific baseline and longer-term trend record. For a vertical-transportation organization, the practical implication is that SOTL5mini can be viewed as a field-deployment component of a broader predictive-monitoring architecture.

* The physical size is approximately 95 × 110 × 28 millimeters including the mounting flanges. The system specifies installation by a certified elevator mechanic. That requirement is appropriate to the equipment environment because installation takes place on an operating elevator car and involves routing power and mounting hardware in an elevator system.

5. Reports

Turning the same motion data into three levels of operational visibility

SOTL reporting is organized around a simple principle: the same motion data can be presented at different depths depending on the person using it. The SOTL system describes three reporting horizons—building overview, six-month trends, and twelve-month judgment. Building owners subscribe to a reporting layer, while service companies can see the diagnostic view underneath it.

The Building Overview answers the immediate operational question: What needs attention this week? It shows equipment status including in service, out of service, and sensor offline conditions. It also presents operating indicators such as door cycles, incomplete closes, and a health badge for each unit. The important distinction is that the health assessment is based on the unit's own baseline rather than a generic fleet-wide threshold.

The Six-Month Trends view shifts from immediate status to developing behavior. It is designed to show which units are getting worse, how quickly the condition is changing, and which direction or operating mode is involved. Examples include open versus close behavior and up versus down operation. The purpose is to provide lead time before a tenant-visible fault and to rank the fleet by evidence rather than simply by maintenance rotation.

The Twelve-Month Judgment view extends the analysis into longer-term decision-making. It addresses questions such as whether a behavior is seasonal, whether the last maintenance visit produced the intended result, and where equipment duty is concentrated. The system includes seasonality, maintenance verification, and usage ranking as information that can carry into budgeting and modernization discussions.

This reporting structure is particularly useful because different stakeholders require different levels of information. A building owner generally needs prioritization and fleet condition rather than raw sensor traces. A service organization needs additional diagnostic depth to investigate a problem. Management may need longer-term evidence to evaluate maintenance strategies, capital planning, or modernization priorities.

The reports are therefore not simply dashboards. They represent the final stage of the SOTL learning process: converting equipment behavior into a decision framework. The system begins with sensing, processes information at the edge, manages devices and identities in the cloud, learns each unit's baseline, and then expresses that learning as a report.

6. How to Attach SOTL to a Car

Selecting the appropriate monitoring path for the equipment

SOTL is designed around more than one installation path. The system includes four approaches: SOTL5mini, SOTL5, SOTL6, and custom configurations. The correct path depends on the equipment and the type of information required. The common objective is that every device feeds the same SOTL system.

SOTL5mini is the compact door-mounted monitor described in this paper. It attaches to the elevator car door using its flanged mounting arrangement. Power is supplied from the car top at 110 VAC and routed with the door travel cables. Network connectivity is cellular or building Wi-Fi, using outbound-only communication. Installation is specified to be performed by a certified elevator mechanic.

SOTL5 is described as a cartop sensor package for elevators that need the original installation path. This provides an alternative to the door-mounted SOTL5mini approach while still feeding the same SOTL platform. SOTL does not provide detailed SOTL5 installation specifications, so a final engineering document should obtain those details from the applicable installation documentation rather than assume them.

SOTL6 provides a different architecture: a direct connection to an elevator or escalator controller. This path is appropriate where controller-level information is the desired monitoring source. Again, SOTL identifies the approach but does not provide controller interface specifications, wiring details, or supported controller families. Those items should be defined in the project-specific installation documentation.

Custom configurations are available for special sensors or controller work for mixed or mission-critical fleets. This is significant for airport environments and other complex facilities where different generations or types of equipment may exist within the same operational fleet. SOTL is positioned custom work as an option rather than defining a single standard installation for all such applications.

Regardless of installation path, the device becomes part of the same SOTL system. The unit has an issued identity, communicates outbound, and is managed through the cloud. Once online, the monitoring device contributes equipment data to the fleet record and to the analytics and reporting layers.

A typical deployment process therefore begins with an equipment assessment rather than hardware selection alone. Identify the equipment type, determine whether car-level sensing or controller-level information is required, confirm the available power and communications path, select the SOTL device, and have the physical installation performed by appropriately qualified personnel. After installation, verify that the device appears in fleet management, confirm the equipment record and sensor association, and allow the system to establish its operating baseline.

A key design objective is that installation should not require an IT project. The security architecture uses a unique device identity and outbound-only communications, while cellular or building Wi-Fi provides the connection path. The result is intended to make deployment practical in operating buildings while keeping the monitoring device connected to the same SOTL management, analytics, and reporting environment.

Conclusion

SOTL is presented as a complete monitoring architecture rather than a collection of sensors. Its defining concept is System of Things Learning: equipment behavior is captured at the point of operation, processed at the edge, securely connected to the cloud, managed as part of a fleet, and interpreted against the individual unit's own baseline.

For vertical transportation and other in-motion equipment, this architecture creates a path from raw movement data to actionable operational information. The system emphasizes visibility, trend evidence, device manageability, secure deployment, and reporting that can support owners, operators, and service organizations.