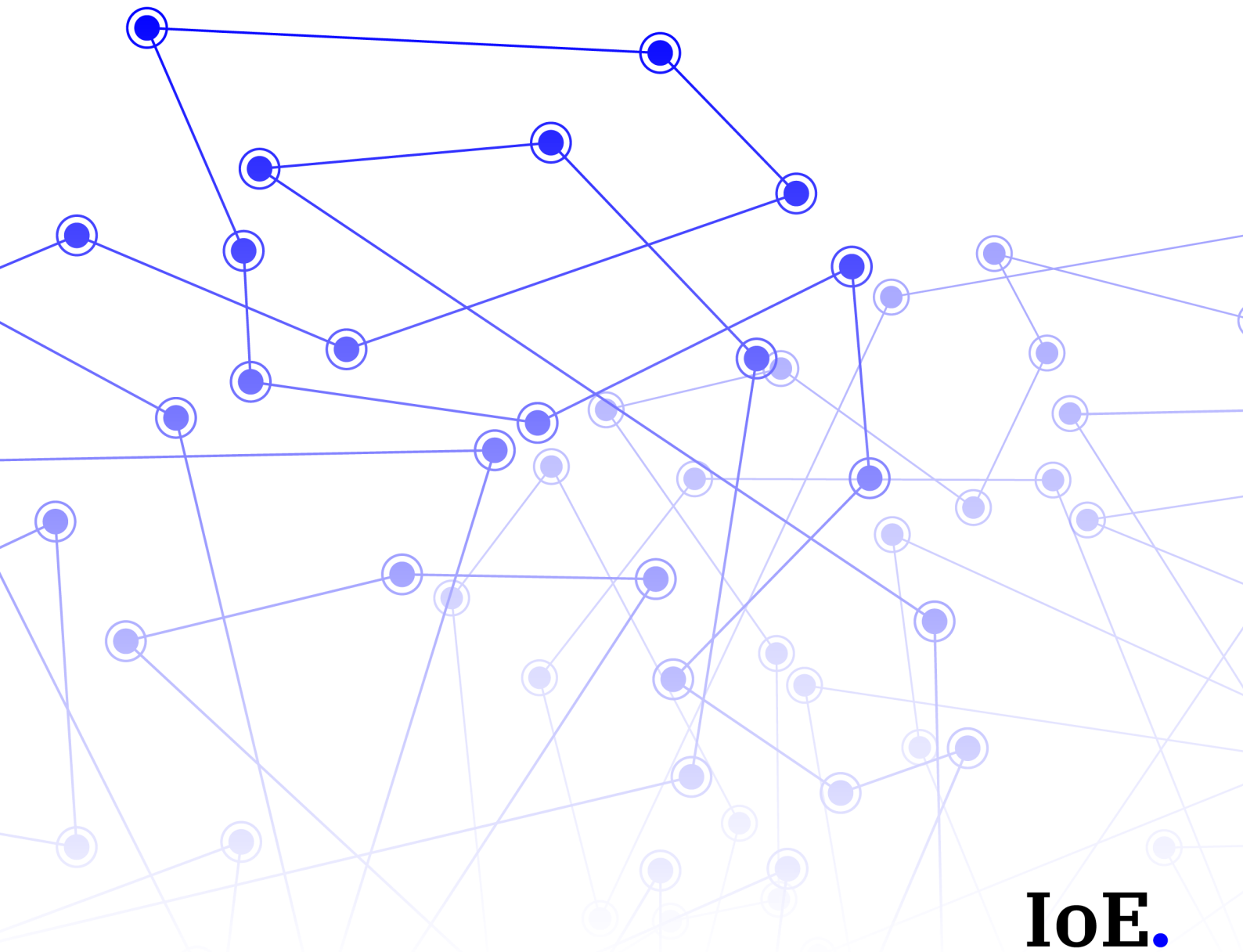


EDEN: Smart Elevator IoT System Infrastructure

IoT Elevator management & predictive maintenance through Eden
AI analytics and real-time data at the edge change how we operate
and maintain elevators currently and for future smart building
construction projects



IoE.

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Abstract

The world is becoming more connected, and we see “smart” systems throughout our daily lives, even if we don’t know it. Smart elevators are a technology that changes how building elevators are managed and maintained and how passengers ride them. Through the use of elevator IoT sensor data (IoT= Internet of Things), operators can monitor the health and performance of everything on an elevator, from a door, pulley system, buttons, scheduling, intercom, energy consumption, connectivity, call management, advanced reporting, predictive maintenance, and more.

This makes maintenance far more efficient and cost-effective, as one technician can service many buildings’ elevator systems. Considering old technology is being phased out and technicians are aging out of the industry, the need for smart elevators is rising as it is easier to maintain many elevators with a single technician.

As the cost of IoT sensors and decentralized edge-computing systems decreases with better production and greater adoption, the market is set to grow substantially in the coming years. EDEN is IoE’s system for managing smart elevators and buildings through sensor data, machine learning, AI automation, and predictive analytics. Let’s look at how data is captured and analyzed through Eden and how that information is used by elevator managers today.

Introduction to Smart Elevators - what are smart elevators?

King Louis XV of France had the first human-powered, counter-weighted elevator built in 1743. (storiaascensori.org¹) The first safety passenger elevator was unveiled in 1853 by Elisha Graves Otis of the Otis Elevator Company at the Crystal Palace Convention in New York City. The first passenger elevator was successfully installed in NYC in 1856 to much fanfare and cheers from spectators. (Case.edu²)

What is shocking is that in over one hundred years, much of the technology that moves an elevator up and

down and opens and closes the door is still the same today. But modern elevators are becoming “smarter” and more intelligent with the aid of current technology. However, there are still limitations regarding maintenance and repairs that have not been improved upon in decades, until now, in the form of Smart Elevator systems.

Smart elevators are internet-connected with data-capturing IoT sensors that offer a more efficient and effective elevator system when compared to legacy elevators. Through the use of elevator IoT sensor data (IoT= Internet of Things), operators can monitor the health and performance of everything on an elevator:

- Door, pulley system, & buttons
- Scheduling & intercom operations
- Energy consumption & connectivity
- Lubricant and humidity levels
- Call management & advanced reporting
- Improved elevator security & facial recognition
- Predictive maintenance, and more.

This makes maintenance far more efficient and cost-effective, as one technician can service many buildings’ elevator systems. There is also less downtime, as malfunctions are prevented instead of repaired after the fact, meaning a more robust elevator health ecosystem is established.

But there are drawbacks when these systems are combined with traditional centralized cloud technologies. Limiting and costly deficiencies can be eliminated by the right system.

Elevator maintenance & operation (Preventative Maintenance)

We often take elevators and escalators for granted. We expect them always to work and are shocked when they don’t. **The reality is they have many moving parts that require consistent maintenance and upkeep.** Leaving

this up to humans without the assistance of big data tools and machine learning poses unnecessary downtime risks that can be incredibly disruptive. Not only to the people who use them but also to the buildings and businesses that rely on them working properly.

Think of a busy city hospital. If elevators fail when moving patients to the operating room, lives can be lost. Downtime for elevators may seem trivial, but considering elevators are the highways for large buildings, keeping them moving is essential to maintain operational efficiency. [Smart buildings](#) aim to mitigate and eliminate the pitfalls of legacy elevator networks.

Drawbacks of traditional maintenance models used today

Legacy elevator system operators and building managers have a problem. A technician can only come “fix” an elevator after something is broken or conduct “routine maintenance” based on a set length of time, like 2 or 3 months. This leads to costly downtimes that riders and building managers find unacceptable. Considering a bustling office building, hotel, or hospital, if the elevators go down, it can spell serious problems for everyone involved. If executives on the 85th floor cannot exit the building without using the stairs, there is a severe problem. The current method of preventative maintenance doesn’t do enough to prevent problems from happening. What you get are elevators that go down more consistently for more extended periods, costing operators millions in lost time and repair costs.

Currently, **many building elevators are under one technician’s responsibility**, overwhelming them and preventing predictive maintenance. The fact is that more technicians are retiring than entering the field, and this creates a knowledge gap. As older elevator technicians retire, there is a real shortage of qualified technicians for engineer repairs and maintenance. So when problems happen, downtime is more extended, and companies face more severe problems. Smart elevators help eliminate the need for on-site fixes and reduce downtime for repairs.

Other Legacy Elevator Problems

Another problem with legacy elevator systems is that many of them were built years or even decades ago. As the number of trained technicians on dated elevator systems age out and retire, the number of qualified technicians is dwindling. This means a smaller and smaller number of technicians must service a growing number of elevator systems. This, in turn, leads to more significant downtimes and costs for repairs as buildings must wait for fewer technicians to arrive and service or repair an elevator system. There is a lack of new technicians entering the field, leading to a substantial drain on qualified elevator service technicians, creating an industry-wide problem for building management and elevator maintenance companies across the globe.

Centralized Smart Elevator IoT Problems (Cloud)

Even current “smart” elevators that send, receive, and store data via the cloud have severe limitations. Because cloud servers are usually physically very far away from the source of the data (the elevators themselves), there are latency issues and bandwidth requirements that slow down system health monitoring and can balloon costs for operators. Lagging speeds and high costs are a concern, but so is downtime. Cloud providers can face technical outages for various reasons and have some fundamental limitations for [industry 4.0](#) and IoT ecosystems.

The biggest cloud computing challenges for IoT projects are:

- Security & password security
- Cost management
- Internet connectivity
- Lack of expertise and qualified operators
- Compliance & control of governance
- Performance & migration
- Reliability & high availability
- Hybrid-cloud complexities
- Portability & interoperability

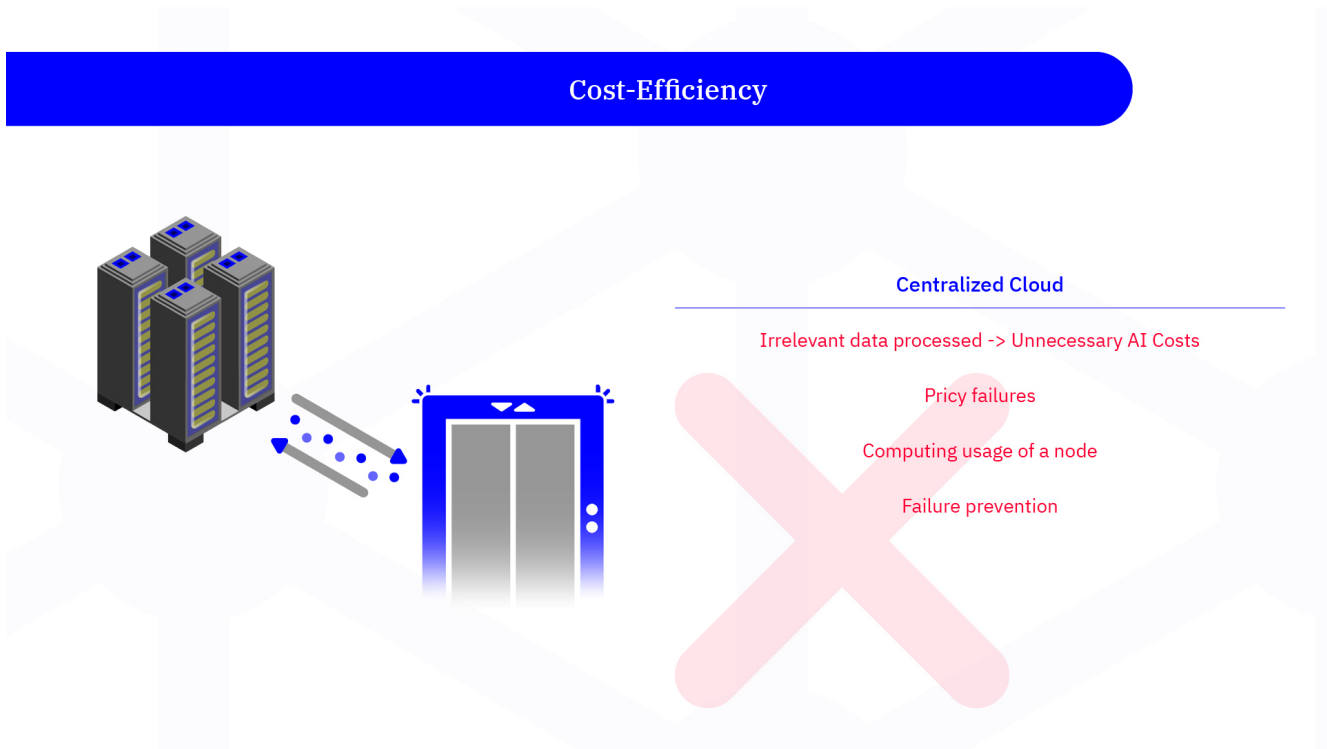


Figure 1. Eden does not use a centralized cloud structure and has no central point of attack

As data produced by sensors & devices is ever-increasing, more and more traditional centralized cloud limitations are being felt by businesses & organizations, large to small.

Today, using Edge Computing eliminates traditional challenges and pitfalls of the cloud. At the “edge” means data is stored and analyzed close to the source where it originated, removing latency issues and improving security through a decentralized network with no central point of attack. Smart elevator operators employing edge computing have seen significant improvements in functionality and reduced computing costs, not to mention better maintenance and overall passenger satisfaction.

Predictive Elevator Maintenance

What is Predictive Maintenance?

Predictive maintenance works by helping determine the condition of various types of equipment to estimate

when and how maintenance should be performed. The concept promises cost savings over routine or time-based preventive maintenance, which are limiting. This is because tasks are performed only when warranted after something is broken (like an elevator door). So, “predictive maintenance” is regarded as condition-based maintenance based on the current state and future predicted state of a system or piece of equipment. The primary promise of predictive maintenance is to allow optimal scheduling of corrective maintenance and to help prevent unexpected equipment failures from occurring.

Internet of Things (IoT) & Edge Computing for Predictive Maintenance

The Internet of Things (IoT) refers to web-connected devices and sensors for a wide range of life and infrastructure improvements. In smart elevators, sensors can monitor all sorts of things, including mechanical functions, door operations, scheduling, etc. Traditionally, this data would be captured and sent to the cloud for processing and storage. The drawback when using the

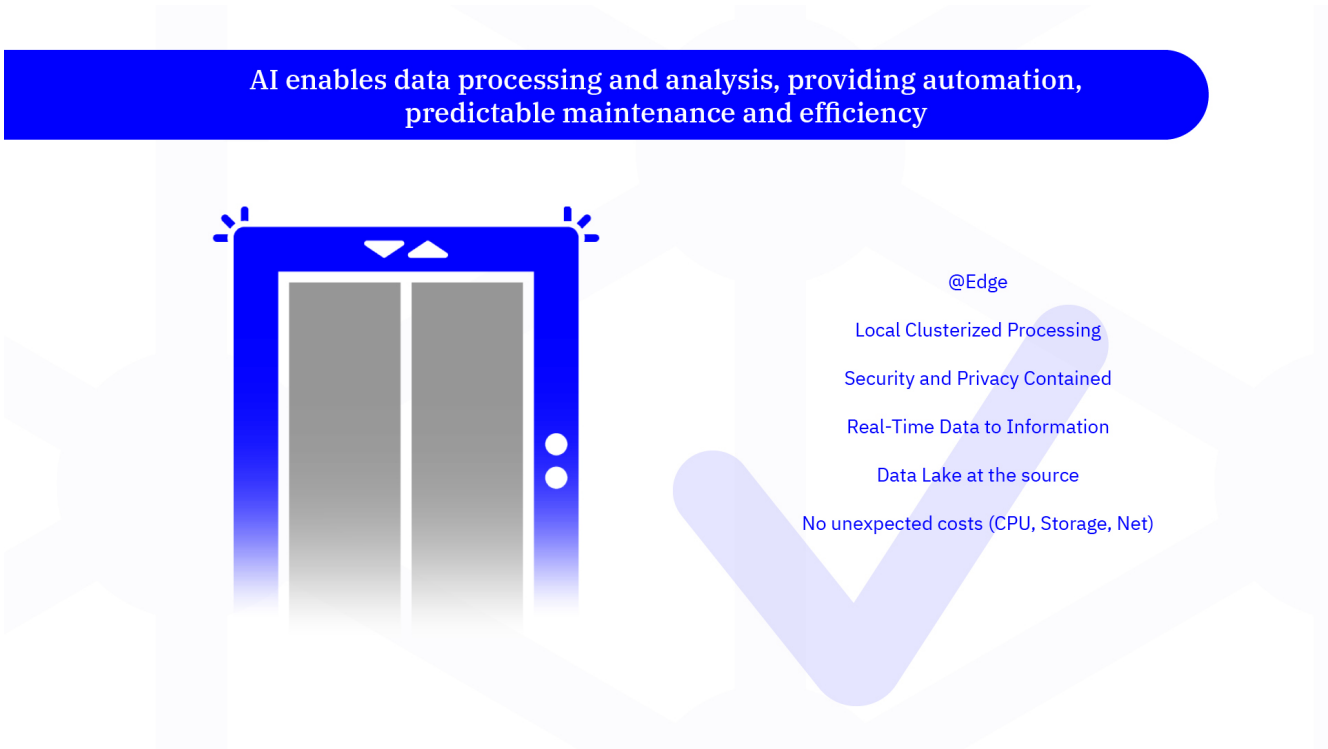


Figure 2. Eden's Smart Elevator Decentralization Initiatives

cloud is that data must travel great distances over the internet to be stored and analyzed at a server farm. This is time-consuming and costly as data must travel using energy and churning code to get to where it needs to be.

Edge computing eliminates the drawbacks of a traditional cloud service, as data is captured and stored “at the edge,” which is on-site and close to the sensors themselves. This dramatically reduces the latency and energy consumed to transmit and receive data, then analyze it and send it back to the operating system for action. Edge computing is essential for modern predictive maintenance and analytics because it allows for increased speed and accurate “real-time” analytics and activities as sensor data is immediately captured and analyzed right at the source, all while improving security as there is no centralized point of attack for hackers and bad actors to target the way there is with the traditional centralized cloud.

Smart Elevator Infrastructure - the Platform

It is important to ensure pulleys and weights are installed correctly and operate safely. But equally as im-

portant is the IoT elevator infrastructure platform that a smart elevator system runs on to conduct, manage, and maintain its operation.

- Can the system handle the data requirements?
- Is the platform decentralized and secure?
- Can the platform be managed remotely via mobile as well as on-site?
- Are costs calculable and understood up front with the system in question?
- Are there enough qualified operators to keep the system running smoothly and securely?

Of course, other questions must be answered when picking an IoT smart elevator platform. Eden is IoE's platform developed for monitoring and analyzing the large IoT data requirements that smart elevators have today.

What is Eden?

Eden is a decentralized, autonomous, portable, secure virtual infrastructure for managing clustered workloads over Depos (decentralized pods) and services facilita-

ting declarative configuration and automation. In other words, Eden is a private online Edge Cluster developed around a sustainable computing core, run on the most efficient programming language today, RUST. Eden was developed specifically for big data infrastructure, industry 4.0, and the internet of things.

Eden is designed using a decentralized model based on scalable device clustering. Data is processed to information locally in the “Eden Edge Cluster” so that raw data is never needed to be pushed to the public cloud, which has security risks, latency concerns, and high costs. Eden uses a compute-efficient and cost-effective model by saving on bandwidth and external resources.

Adding new devices (i.e., IoT sensors) as nodes is simple. It makes it possible for any device to contribute computing resources over an intelligent mesh network so computing can happen where needed the most and close to where the results will turn into usable action.

EDEN Smart Elevator Automation benefits

Eden-installed elevators will tell Stakeholders if there is a problem, like a door malfunctioning. Eden can do this on any elevator or escalator (regardless of the brand). The health status of each elevator is sent to the Stakeholders. Add an [EDEN](#) sensor to each, and Maintainers can track the health over time and find issues before they become problems.

Staying ahead of problems, fewer Maintainers can attend to many more elevators. With EDEN in place, Stakeholders can view the health of their assets in one place, on one screen, and on mobile devices. Technicians can detect and monitor problems before arriving on-site so that repairs can be made more quickly without delays or lengthy repair part sourcing time frames.

Eden offers many benefits for companies, institutions, and operators across all industry verticals. Some of Eden’s top automation benefits for elevator operators include:

- Automatically alert technicians when a repair is needed or will be needed soon.
- Use personnel scheduling & connected FOBs to ensure elevators are picking up and dropping off passengers efficiently (instead of going up, down, or idling randomly).
- Monitor air temperature, humidity, air pressure, call button & intercom operation, scheduling, system health reporting, and more.

Eden Security Beyond Cyber

Eden is also developed with quantum-safe tunnels using polymorphic encryption keys and a consensus blockchain to verify the data moved between the nodes over the tunnels, thus creating [trusted data private gardens](#) and achieving data trust in Zero-Trust environments. So operators can rely on the security of the system.

The orchestration of computing and storage is done via service manifests that describe service rules, policies, and logic. An autonomous knowledge-based AI manages the underlying orchestration mechanics using network consensus over the blockchain as a deciding mechanism for verification and data quality assurance.

The orchestration dynamically updates the cluster topography to fit the current workload. Eden Depo services are generated and deployed similarly to container images; the exception lies in that Eden is Messaging Passing Interface (MPI), and the AI cluster is enabled as a default.

Eden’s top security benefits include:

- **Defense against denial of service attacks (DDoS):** Eden is completely decentralized, so DDoS attacks are mitigated with no central point of attack for hackers and bad actors to target.
- **Malware detection:** malware attempting to replicate itself as nodes can be detected immediately, and the compromised node will be identified via data transfer check-sum consensus via the blockchain because the

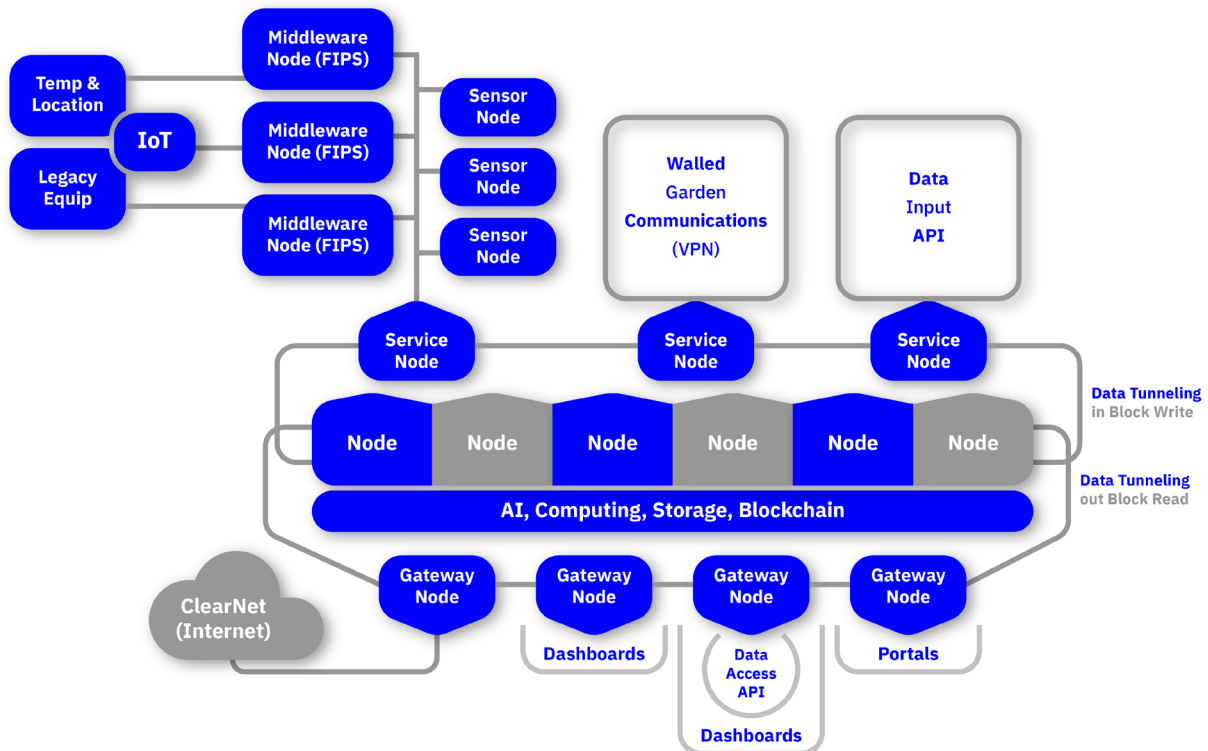


Figure 3. Eden's IoT deployment in and out data use case + security infrastructure

check-sums of data transmission will not match or synchronize with the received data amount of the nodes and will be flagged and segregated from the main network preventing system-wide compromise.

- **Bad data & bad actor detection:** utilizing verification and sanity checks on data amounts entering and traveling through Eden on every node and port prevents corrupt data from being transmitted or received and bad actors from gaining control of any system functions.
- **Secret & configuration management:** Eden allows users to store and manage sensitive information (i.e., passwords, OAuth tokens, user IDs, encryption keys, etc.). Users can deploy and update “secrets” and application configuration without re-building entire Depos and exposing intellectual property or other guarded secrets in your service.

Smart Elevator Market Opportunity

The IoT market is relatively new, and smart city and construction projects are just starting to pick up steam. Because of this, IOT Elevator adoption is still in its infancy due to the elevated costs of new technology and the need for providers. It is estimated that of roughly [18 million global elevator & escalator systems](#)³, just 0.5% are smart systems connected. Considerable human resources are required for monitoring and maintaining them as well. The UN Department of Economic and Social Affairs states that 60% of the global population will live in urban areas by 2030 and nearly 70% by 2050. This means a huge need for new construction in urban areas in the coming years.

As the value of IoT starts to be more understood and implemented, there is a substantial market opportunity for businesses that position themselves to take advantage of smart elevator installation, maintenance, and platform development. Urban populations are growing,

and there are increasing levels of urbanization in the developed and developing world. Energy consumption, efficiency, and cost are at the forefront of new construction focus. Considering smart elevators can be useful in all building types (residential, commercial, institutional, industrial, etc.), there is a huge opportunity waiting for the right technology to take market share.

Conclusion

Our world is getting more interconnected, and we're starting to head to the next phase of global commerce and technology in the form of the Internet of Everything. Elevators are just one of the many areas in which IoT will shape our lives in how we work and play. Urban areas are growing at some of the fastest rates in history. Construction to meet growing population demands is becoming more technologically focused, with automation and efficiency at the forefront of builders' minds.

But the industry has a problem with outdated legacy infrastructure security and pushback from developers regarding costs for deployment. Security risks continue to grow daily, and centralized systems are not prepared to secure society's infrastructure.

The Internet of Everything's Eden platform is a true IoT ecosystem the market has been waiting for. We are accepting applications for our Planet Partner Program to work with the Eden system and improve your operations across the board.

You can apply at the link below, and an Eden crew member will be in touch shortly:

<https://partners.ioecorp.com/apply-partner>

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