SOLUM

The Definitive Playbook of Electronic Shelf Labels

SOLUM Electronic Shelf Labels White Paper 2020

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Introduction

"Our future growth relies on competitiveness and innovation, skills and productivity... and these in turn rely on the education of our people."

- *Julia Gillard*

This guide is meant for those who want to explore the technical side of electronic shelf labels within the context of a retail and industrial space. We delve into the multiple moving parts that make up the entire electronic shelf labelling system, and walk you through the process of everything: from the when the individual units are installed into the shelves, to the consumer's physical contact with the ESLs, to the backend software that masterminds it all.

This time, we want you to understand not only *why* electronic shelf labels are relevant in today's IoT-enabled business environment, but also *how.*

SOLUM has developed a wireless communication network comprised of hardware, software, and operations systems that make up one singular, revolutionary SOLUM Electronic Shelf Labelling system. It's all here, right at the palm of your hands.

We're always happy to answer questions. Shoot us an email at solumesl.com/contact/inquiry.

How SOLUM Electronic Shelf Labels Work

A complete ESL system comprises of 4 major components: Servers, Gateways, Electronic shelf labels, and Mobile terminals.

First the AIMS label management software on the server processes the information for an item, which gets packaged into data packets: pricing and product information.

Then, AIMS sends the data packets to the Gateways via a 2.4GHz Wi-Fi signal.

Once the data packets are transmitted to the Gateways, they will then be sent to the specific ESL to update the price on the display.

The ESLs, each with a unique identification code, will receive the information and present the specific information associated with the product in place. Information can be sent to all the label devices, or only to specific label devices.

This communication process allows the ESL displays to be automatically updated whenever a product price is changed on the server.

Brand-new SOLUM Newton Gateways can cover 50K tags compared to the old Gateway's 30K tags. These signals can be received within a range of 25 – 30 meters per gateway.

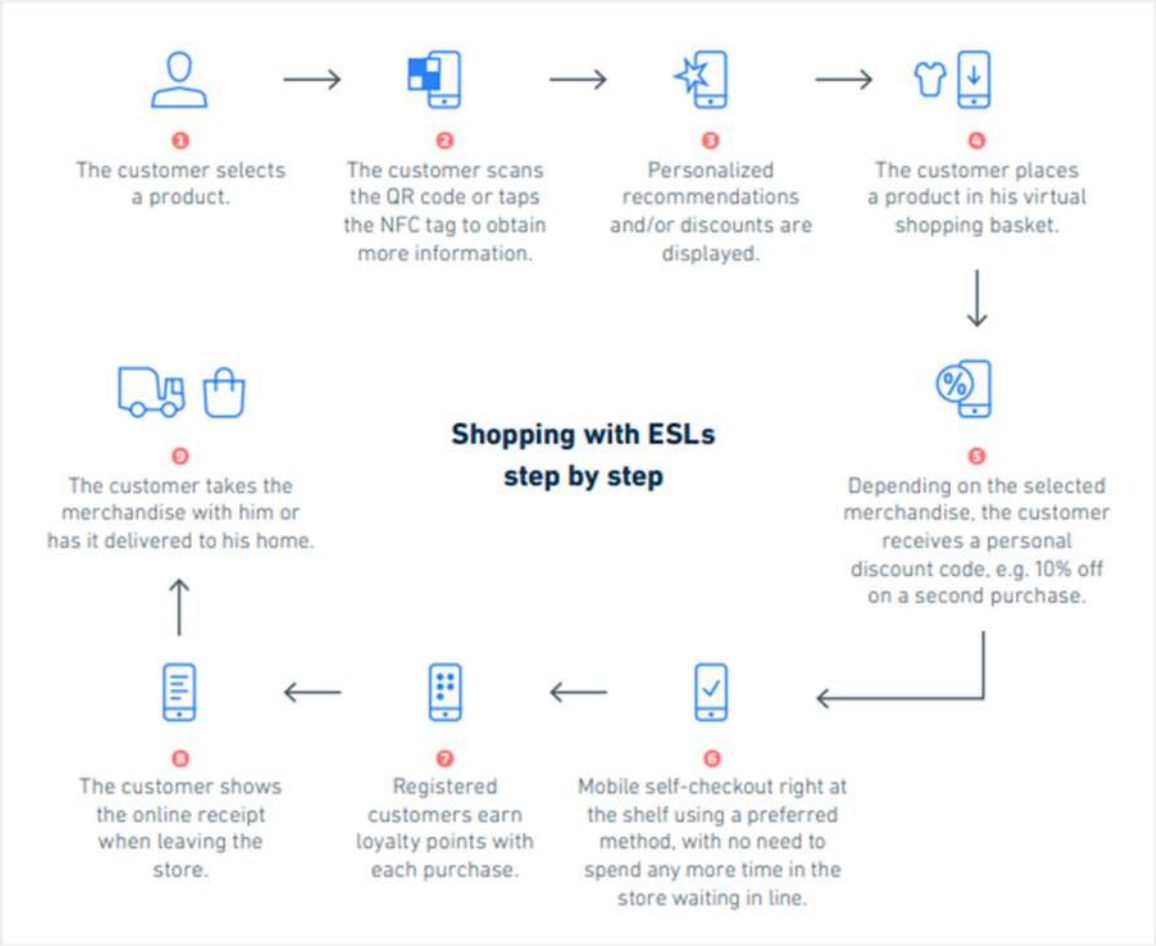
Store associates can use the smart mobile terminal to review and manually adjust pricing and other product information whenever necessary.

**insert diagram of work flow here*

As for customers, ESLs give an entirely new meaning to the term “shopper experience”.

Thanks to the newest NFC technology in Newton ESLs, customers can simply tap or scan a label using their mobile phone to access a variety of capacities: get personal recommendations and discounts, read further information about the product, sign up for store membership, adds a product to a virtual shopping basket, to name a few.

The following diagram shows the process that customers follow when utilizing Newton’s NFC feature:



SOLUM ESL Partners and Clients

What do ESLs do exactly?

Ten years ago, SOLUM brought up an innovation in ESL technology by introducing the first e-paper based ESL to the market. In 2020, we launched Newton, the most innovative ESL in the last decade. Our team at SOLUM developed the Newton System—a special system that has 10 times faster speed and double battery life. Powered by the extended battery life and new features (real-time speed, LEDs, buttons and LBS), Newton is the right product to investigate new use cases in promotion, operation, and customer interaction.

With Newton, there's a solution for every retail sector.

SOLUM offers a wide range of uses for electronic shelf labels.

1. ***Clothing:***
   In the clothing sector, fashion tags are replacing RFID tags as the preferred means of thwarting shoplifters. They also allow customers to conveniently view other appropriate products to go with a selected item or previous purchases. Choosing a different size or color is also easy without having to laboriously search for it in the store.
2. ***Consumer electronics:***
   Merchants in this sector face especially great competition from online dealers and need to be able to react quickly to changes in price. Customers, for their part, can use ESLs to get more information or product evaluations or watch product videos.
3. ***Food and beverages:***
   Here ESLs greatly increase efficiency, because staff no longer need to spend hours a day printing out and swapping hundreds or even thousands of price tags. Specials and discounts can be quickly offered with minimal effort. Flexible price adjustments can also help sell off unsold perishable goods that would otherwise just be disposed of at the end of the day, when they've lost freshness.
4. ***Hardware:***
   Stores that sell building materials and hardware are typically frequented by the same patrons. With ESLs, displaying tiered pricing (aka showing customers how much discount they're getting if they sign up for a membership) is so much easier. The ESL's NFC capability, which can be accessed by customers by hovering their phones over QR codes on the electronic labels, can be used to help direct them to your store's membership sign-up sheet. In addition, NFC technology provides customers with a wealth of product information at their fingertips.
5. ***Convenience products:***
   Many customers appreciate being able to quickly purchase snacks, beverages and other items for immediate consumption. If they can pay for them right at the shelf, they no longer have to spend time waiting in line at the register and their shopping experience is elevated to a new level. Thanks to price automation and mobile self-checkout, this is also conceivable for unmanned stores.

Industrial Use Cases

Warehouse management is a highly-involved skill, especially now that e-commerce and other digital platforms have allowed the manufacturing industry, as a whole, to grow to exponential heights. Legacy systems are becoming irrelevant, giving way to newer practices especially in inventory management and logistics operations.

SOLUM offers a new, digital way to improve your inventory tracking and asset management: Newton electronic shelf labels.

From allowing real-time, highly accurate control over inventory, to providing streamlined workflow planning, and finally to guaranteeing that your finished product is manufactured with complete precision, Newton can give you a wide range of functionalities across the board… all while saving your company time and money. Here is how.

1. Pick By Light

Installed on each box, ESLs feature a blinking LED light that can be activated to indicate the position of the material on the shelf, thereby making it easier for workers to find parts for assembly. By pushing the picking button, the pick procedure can be confirmed, allowing the operator to move to the next box.

Advantages:

a) Easy and transparent inventory management
b) Elimination of mistakes and costly returns
c) Operators are able to work faster
b) Real-time update of stock information

2. Smart Ordering

Operators can simply push a button on the ESL to generate and automate the re-ordering process for a specific box / good.

Advantages:

a) Easy and transparent inventory management
b) Reduction / Elimination of backlogs
c) Real-time update of stock information

3. Trolley Tracking

ESLs serve as digital routing slips for internal transport, following the delivery process from parts selection to assembly. These products are assigned with an MES / ERP system and categorized into Part, Semi-goods, Finish Goods.

Advantages:

a) Easy and real-time control of part
b) Paperless and digitalization of procedures
c) Registering incoming and outgoing goods

4. Roaming Solution

Similar to Trolley Tracking but instead of within one warehouse, digital routing slips track trolleys moving from Plant A to Plant B, or between two different locations. Newton enhances long-distance trolley tracking as well as the registering of incoming and outgoing goods.

Advantages:

a) Paperless and digitalization of procedures

5. Equipment Management

ESLs digitally display essential equipment information (ex. date of procurement, current stock count, capabilities, etc.) which helps employees practice efficiency and allows better control over inventory.

With the NFC tagging feature, a last / next technical check may also be implemented.

Advantages:

a) More transparent and efficient equipment management
b) Real-time, accurate inventory updates

6. Visualization

ESLs show a host of product information (location, stock status, receipt date, and much more) on a digital screen, as opposed to paper labels which are limited in that capacity. Features such as multiple-page display screens allow ESLs a range of functionalities that paper labels do not have.

Advantages:

a) Paperless system and digitalization of procedures
b) Monitor product information and workflow with ease
c) Real-time updates on inventory and important equipment data

7. Manufacturing Instruction

Warehouse employees are equipped with clear manufacturing instructions or planned daily production or activity which can be accessed from the ESLs themselves.

Advantages:

a) Digitalization of procedures means reduced paper consumption

8. Job Instruction

ESLs mounted on the product in the line display real-time changes in the instructions, which are controlled from the main server. This gives workers at the line clear task instructions in the most direct, efficient way possible. Simultaneously, supervisors are able to track the product and confirm the work status from the main office without having to monitor work on the floor.

Advantages:

a) Paperless system and digitalization of procedures
b) Clear and real-time work instruction
c) Minimize human errors

9. Work manual

With the use of ESLs, paper working manuals are made irrelevant, since instructions can be displayed on ESL screens directly.

Advantages:

a) Paperless system and digitalization of procedures
b) Reduction of labor costs related to filing of the manual
c) Work manual is easily accessible to employees

Retail Use Cases

As the landscape of retail continues to digitally transform, businesses are realizing that legacy information systems are the biggest barriers to providing a cross-channel shopping experience for their customers. Retailers of all shapes and sizes and representing diverse trade spheres are seeking to move away from aging structures and make use of the beneficial value of the data.

SOLUM's electronic shelf labels offer solutions that bridge that technological gap. Our 20 years of experience have allowed us to generate functionalities within Newton that are specific to retailer needs, to help you align online and in-store customer processes, as well as align those processes across all channels, including stores, the Internet, and mobile devices.

Ultimately, Newton will allow your business to gain process efficiencies that will boost customer satisfaction and improve the profitability of in-store consumer purchases.

1. Dynamic pricing

To keep up with competition, it is essential that retailers practice dynamic pricing in their stores. But the problem is that the vast majority of retailers are still using paper labels, which need to be changed manually. This is not only time consuming, it also allows for inaccuracies between the amount on the label and what's charged at checkout. ESLs provide an accurate, real-time solution to implementing and managing dynamic pricing in stores.

Advantages:

a) Latency risk close to zero
b) Price updates can be done any time, even during operating hours
c) Consumer trust is not put at risk

2. Improved shopper experience

Newton ESLs come with two programmable buttons that can provide variable shopper interactions. Shoppers can press a button to flip the page to show more detailed information about a product, or to call a store associate for assistance. Once a store manager receives this alert on their mobile or PDA device, they can simply send a notification to the ESL, which will display a message such as 'On the way', or 'Not able to help'.

Advantages:

a) Improved customer service
b) Modern customer experience

3. Smart ordering

The programmable buttons serve another function: instead of preparing a list manually on a notebook or PDA device, store managers can go around and simply press a button on the ESLs to make a virtual list on the server. Once the list is uploaded, it is easy to monitor the re-stocking or even to place an order to their central distribution center.

Advantages:

a) Improve inventory operations and asset management
b) Reduced labor cost

4. Pick-by-light

With the combination of buttons, multi-color LED, and real-time speed, Newton proves to be the best choice for Pick by Light applications. Store associates can easily find and pick exact items on the shelves by looking for one out of seven LED colors, indicating a specific shopper's order. The buttons can then be used to confirm that the task has been fulfilled—all happening in real-time.

Advantages:

a) Faster and more efficient operations
b) Improved customer service
c) Reduced labor cost

5. Operation indicator

With 7-color LEDs, the possibilities for the ESL's function as operation indicators are endless. A certain color of LED can be programmed to indicate low battery, another color for stock rotation, yet another for re-stocking, etc. In addition, the LEDs can also be programmed to blink at specific time intervals.

Advantages:
a) Optimization of efficiencies
b) Reduced labor cost

6. Customer interaction

Another way that ESLs may be utilized in the retail store is to provide instant product information to the customer. For instance: a red LED could stand for promotional items, yellow for allergy alert, green for organic, blue for new arrivals, and so on.

Once the shopper has reached the label on the shelf, they may press the buttons to flip through multiple digital pages containing in-depth information about a product, or access the information on their mobile device via NFC. The data could vary from nutritional facts about a food item, to whether a product is on sale, to how many stocks of a certain item are left. They can also add items in the store to an online shopping cart and make a payment digitally using the NFC function.

Advantages:
a) Modern customer experience
b) Easy access to a breadth of information

7. Label positioning

Newton comes with its own location-based system using Anchor Tags. With this technology, shoppers can search for a product on their mobile device, then a certain color of LED can be lit to indicate the location of the product. A digitized map of the store also makes looking for a product easier. The location data of a tag is automatically collected 2~5 times which is configured by a server.

This label positioning also allows store associates to easily find an item's position for picking, restocking, and replacement.

Advantages:
a) Product navigation made easier for shoppers
b) Provides notification to assist refill operation
c) Most cost competitive solution as it doesn't need any additional infrastructure nor a different server

Newton: Cutting Edge Retail Technology

The N system is a special system designed to address the most common use cases that a majority of retail and warehouse companies experience on a daily basis.

Part of the new N system is the dashboard that lets you monitor the details of your labels. For instance, command progress, battery health, and online offline state.

Another N system element is the renewed gateway for Newton. With a capacity of 50,000 labels and a communication radius of up to 30 meters, its digital numbering system offers a modern and digitized look. Managers can easily identify the device by ID of the Gateway.

One of the most innovative improvements with Newton is the load balancing system. This means that the number of connected levels of each gateway is always evenly distributed.

We know that cost efficiency is also important, and we factored that in the new system. The Newton USB gateway can simply be plugged into your computer Wi-Fi access point or even directly into an existing gateway.

Apart from these developments, the emergence of the Newton system comes with a long list of features that sets it apart from all other ESLs in the market.

Key Features

SPEED

With the N System, Newton tags have ten times the update speed of the current system. 50,000 tags can be updated all within 5 minutes with 1 Gateway, which means in 0.1 seconds per one tag.

Value add:

With this feature, you can implement price markdowns during store operation hours in real-time speed, leading to more sales and profit and in retail supermarkets, to less food waste.

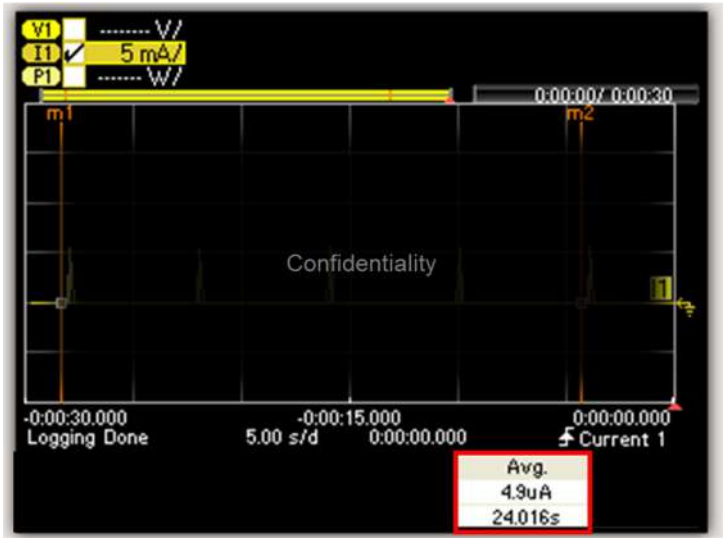
Items	Current Model	
Unit update	~20 sec	~2 sec
15,000 update w/ 5 GWs	1 hour 15 minute	~5 minute
LED Blinking Response	~10 sec	~2 sec

BATTERY LIFE

NEWTON tags now have ten years of battery life in room temperature. This is two times better than the current system which can last five years.

Value add:

It allows for more updates, heavy usage of LED blinking and buttons, and even for tag positioning. Longer battery life means more possibilities.



Newton Model Average Current **4.9uA**

10 YEARS

DURABILITY

Having a battery that can last for 10 years will have no meaning if the product itself won't last that long. Tags can break for many reasons; they can be dropped, hit by shopping carts or even stepped on. NEWTON's new shock resistance is now up to 323.4 kg m/s^2. That's an 80% improvement from previous generations.

* Test Device : FGN- 50B

M2	Competitor	M1	M3
			
180.1 N	200.9 N	283.7 N	323.4 N

WEAK **STRONG**

DESIGN

Giving a premium and digitized look to wherever you choose to put it.

The real beauty of NEWTON is that it is customizable. You can incorporate your own colors, patterns and logo.

That's what we call branding.

Enhancing **Brand Awareness**

Differentiated & Aesthetic **Design**

Diverse **Sales Promotion** Available

LONG-LASTING E-PAPER COLOR

The available display color is Black/White, Black/White/Red and Black/White/Yellow. The screen is also completely sealed to prevent the display colors from fading or drying out. Now, your display can have that crisp color for a more extended period.

IP67 WATER & DUST PROOF
It is fully water and dustproof. It can last up to 30 minutes in water.

Value Add:
- You can put it anywhere, wet or dry in the fish, meat, or garden sections.
- Long Life of the Label: Even the tiniest dust particles won't hurt the label./
- Prevent the E paper from drying out.

HIGHER RESOLUTION
NEWTON resolution comes crisp and clear. It`s upgraded by 20% compared to older generations.
VALUE ADD:
- a clearer representation of the fonts by a higher resolution allows the presentation of more content on small label sizes
  (in compliance with legal requirements)
- A better customer experience, because content is easier to recognize

1.6" : 184dpi
2.2" : 156dpi
2.9" : 145dpi

BUTTONS
One of the most prominent new features of Newton are the buttons.

Value Adds:

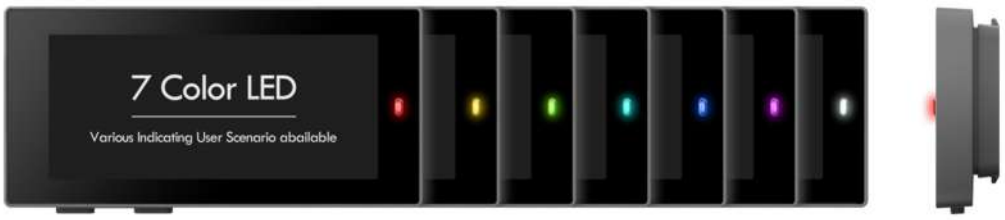
- Buttons are completely configurable for different purposes.
- Buttons can be used to change pages, call service help, report on low or diminished stock on the shelf or job confirmation.
- You can set the command and meaning of long and short presses.

LED VISIBILITY
7 LED colors allows more simultaneous and specific usage by allocating colors to each manager or giving a different meaning. This bright and multi-color LED can be visible from 180 degrees.

Value Adds:

- Easy product finding, restocking indication, and identifying a different product or promotion categories.
- The LEDs can be used for an indicator of the stock rotation, even able to show a different level or category of it with multi-colors.

7 COLORS LED
The built-in multicolor LED supports seven different colors



7 PAGES
It comes with an upgraded page capacity which means that instead of 3 pages you can now save up to 7 pages with different layouts.

NFC FUNCTION

Near-field communication, or NFC, is also included.

With NFC, you can implement mobile payment, linking to a product information page, or getting a digital coupon.

NFC Solution User Scenario 1: **Self-Checkout**

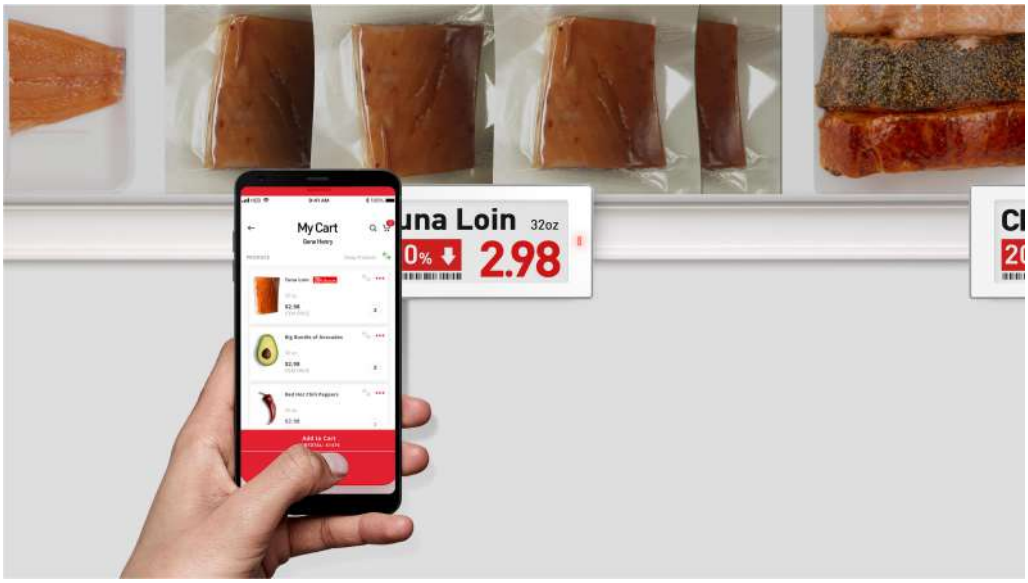
Step1. Mobile phone tapping to tag for making mobile shopping cart list

Step2. Make payment with mobile phone

Step3. After payment, generating barcode as a digital receipt

NFC Solution User Scenario 2: **Marketing & Digital Coupon**

Mobile phone tapping to tag for an additional product description, commercial page / video and receiving digital coupon.



TAG POSITIONING

NEWTON comes with its location-based system. The Anchor tag is needed to implement the solution. (price similar to a regular tag)

A tag measures a signal with Anchors and send its measurement to a server, generating X, Y positioning data.

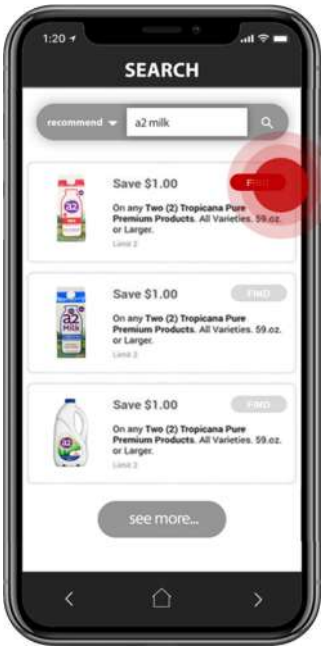
We recommend putting the Anchor one unit per a shelf (in every 1~2 meter). The accuracy is then in about 1~2 meter.

Value Adds:

- Product navigation/ Indication for Refill operation or for product search of end customer
- It is the most cost competitive solution as it doesn't need any additional infrastructure nor a different server.
- For easy recognizing right after user search a product a certain color of LED can be lit on to indicate the product.
- Anchor Tag

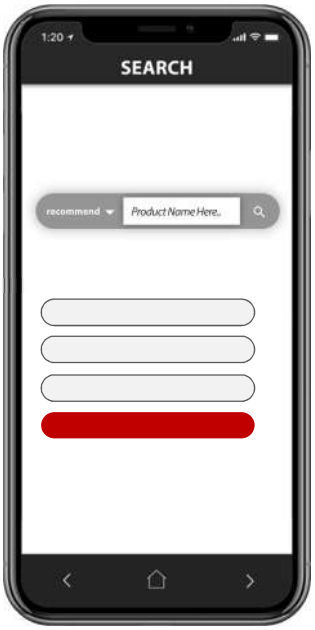
- Acts as a signal transmitter at a pre-defined (i.e. known) location
- Typical number of required anchor labels : About 3~5% of the total number of ESLs installed in the store

LOCATION BASED SERVICE



CASE 01
Finding by
Customer with APP

CASE 02
Finding for Own
Product by Customer



CASE 03
Relevant Product
Recommendation

CASE 04
Searching Product
with optional features

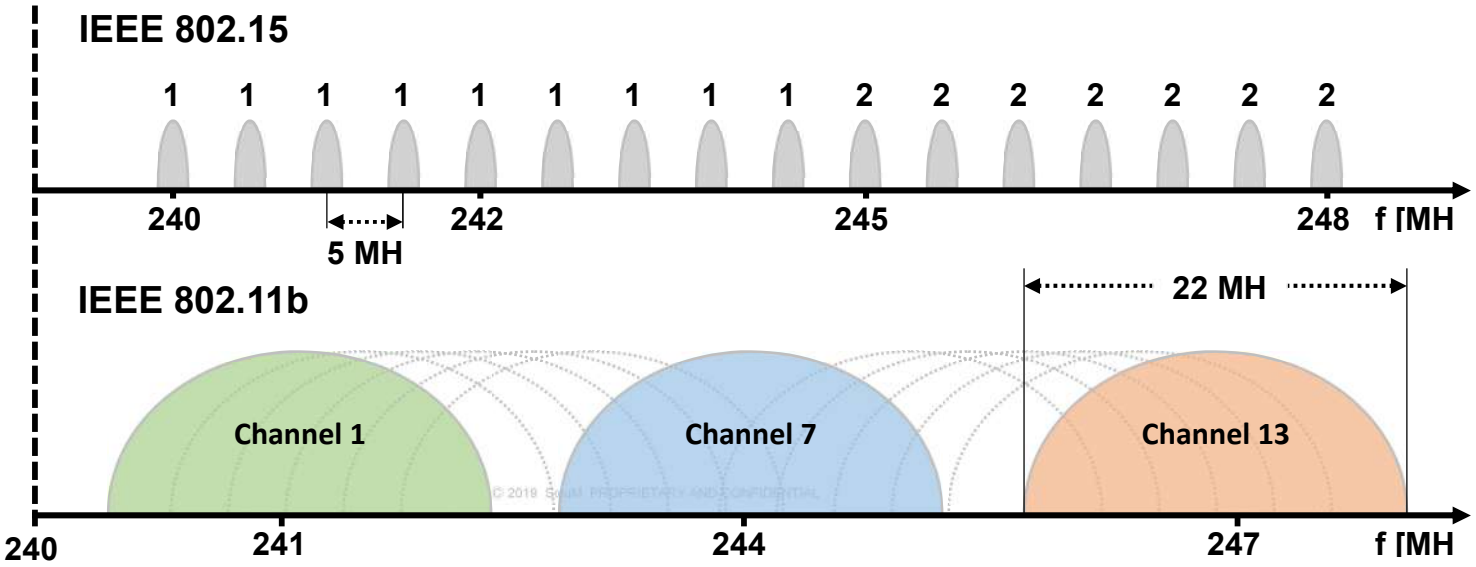
RF CHANNELS

Old generation ESL's have about 11~16 RF channels. NEWTON is ahead of the game with over 60 available channels.

Value Adds:

- There is almost no Wi-Fi interference issue.
- It even has auto channel selection system which avoids any potential channel collisions.

** The diagram of the current Zigbee solution, not Newton*



LINE-UP

NEWTON comes in 11 different sizes, ranging from 1.6" to 13.3" - covering almost all your current paper label sizes. We made sure you won't have to make any compromises here.

CLICK HERE

Administration Capabilities

For every organization, SOLUM provides a Company Administration Station:

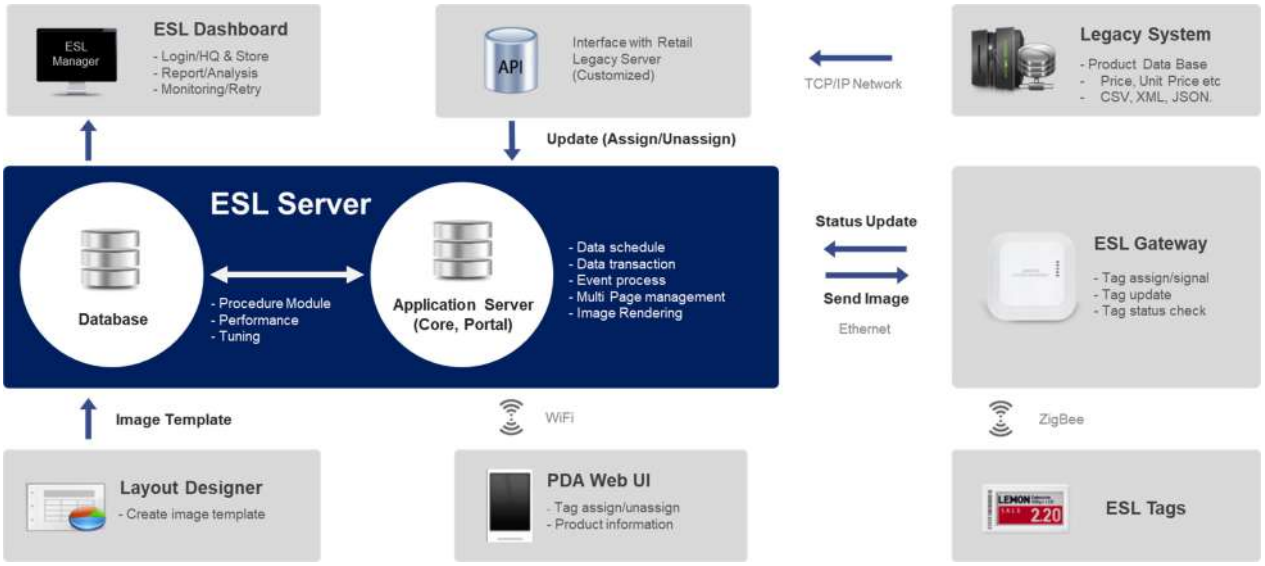
A. AIMS

AIMS is a cloud-based network monitoring solution that caters to large and midsize businesses across various industries such as healthcare, retail, e-commerce, manufacturing, energy, and more.

More than price update automation and inventory management, AIMS software is capable of dealing with all the tasks and functions that must be performed as part of the day-to-day operations of your business. It can be connected to all existing data sources which are relevant to your intended use of our ESL solutions, all while providing easy-to-use controls for commands such as price updates, stock replenishment, or locating distinct items in the warehouse.

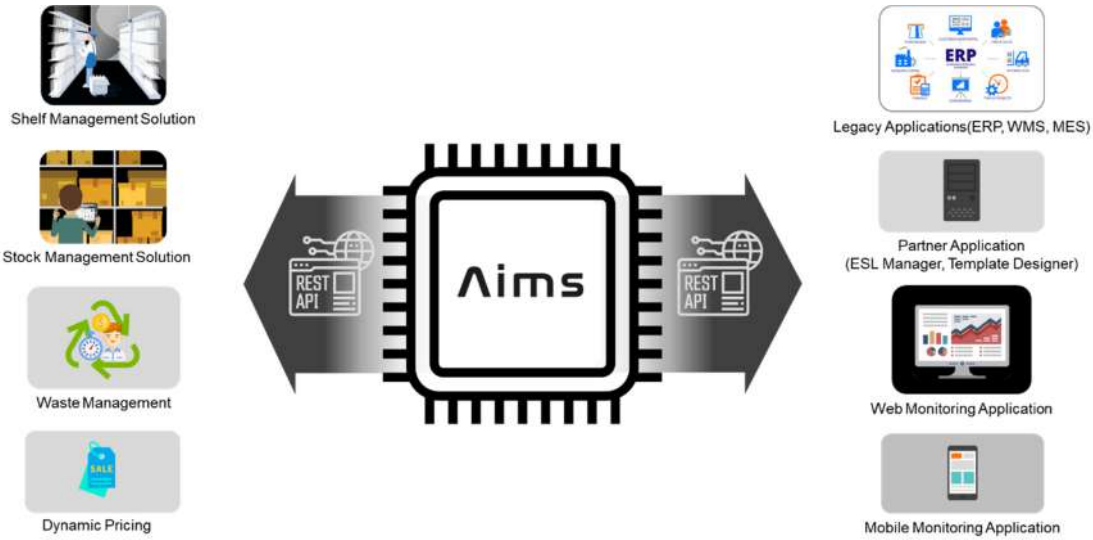
With this software, you have centralized control over all the ESLs located across the premises and even in other locations– resulting in reduced infrastructure costs, improved staff productivity, better data management, and increased revenue.

Basic Architecture of AIMS



Architecture of AIMS

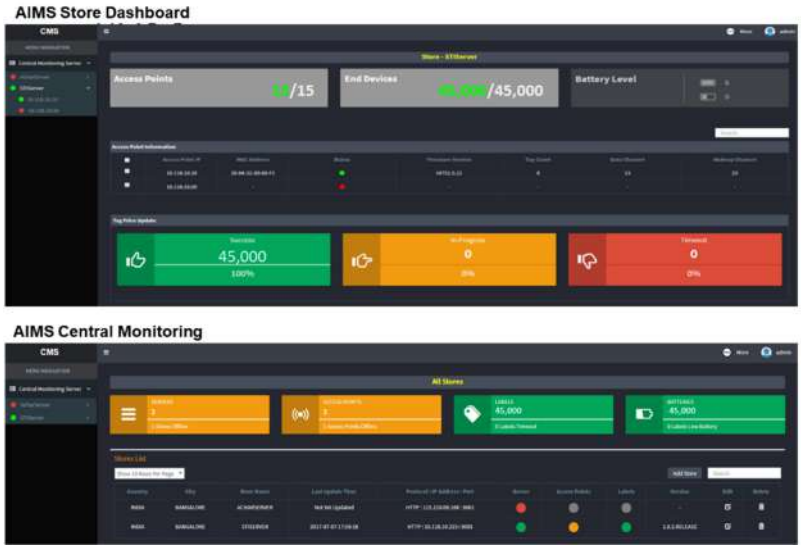
This is the architecture of AIMS (Advanced Information Management System). The main fundamental components of AIMS are the Application Server (Core, Portal), the Database, the ESL dashboard, the Layout Designer and the Web PDA application. This can cover all ESL operations and management purposes, yet at the same time it offers the most efficient way of integrating with the retailer's legacy system. Through its RESTful API, the modular architecture of AIMS enables it to quickly and easily integrate with other store IT solution.



Modular Architecture of AIMS for easy integration with 3rd party

AIMS Dashboard

ESL performance is one thing, but ESL management is another. With the AIMS central dashboard, you can monitor the details of every tag such as its on/offline status, operation progress, battery status, and RF signal strength, etc. You can also check on the health status of each Gateway. The central monitoring system supports role-based access control for each user that restricts their level of access accordingly to their role. So for example, the dashboard can only display information for a specific store (for store associates or managers), for a region (for regional managers), for a country (for national managers) or on a worldwide scale (for headquarters).

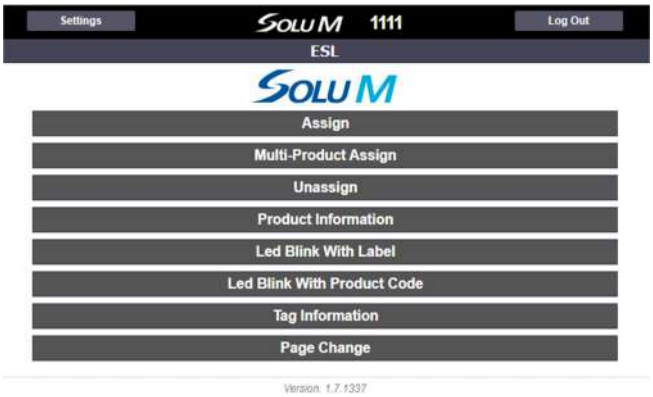


AIMS Dashboard

Features	Description
Offline/online Gateway	Total number of gateways and online status (green)
Labels	Total number of labels that are active / inactive
Gateway-IP	IP address of all gateways that are online / offline
MAC-Adresse	MAC address of all access points
Status	Status of the access point - connected - not connected
Firmware-Version	Firmware version of the access point
number of labels	Total number of labels associated with the a ccess point
data channel	Data channel used for access point
Wakeup Channel	Wakeup channel used for access point

AIMS WEB PDA Application

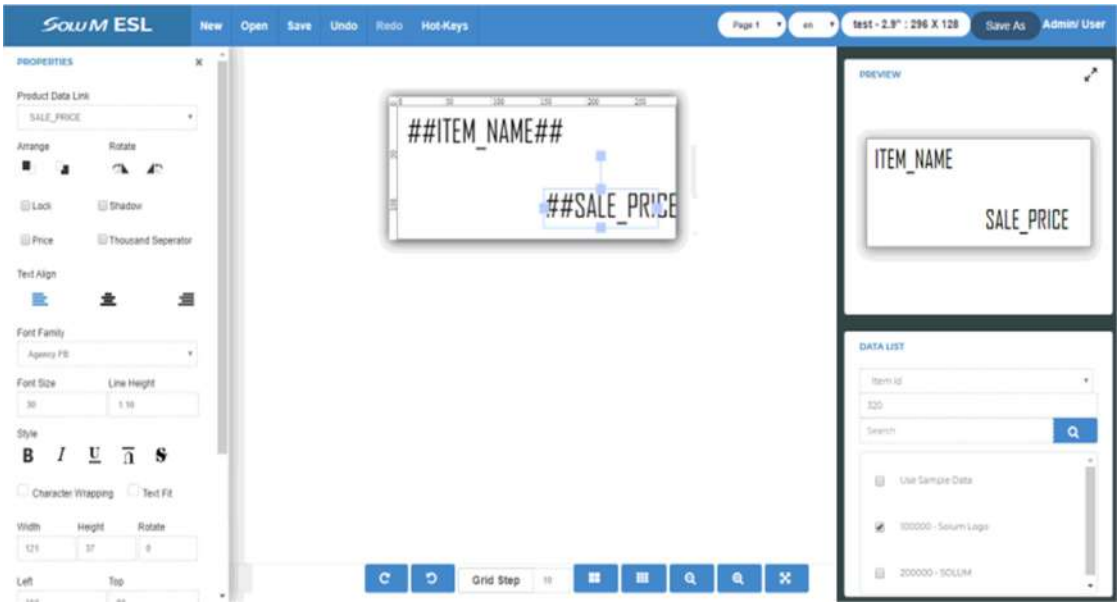
The AIMS Store Application provides a Web-Based ESL manager for PDA devices and mobile applications for Android and iOS devices. From these applications, a manager can implement all daily ESL operational features, such as assigning products to tags, checking the assignments, updating the status, and executing LED blinking commands, etc.



AIMS WEB PDA Application

AIMS Layout Designer

SoluM AIMS provide an easy-to-use user-friendly Layout Designer tool for creating display templates for ESL tags. All layout requirements of retailers for each size format can be implemented with the AIMS Layout Designer.



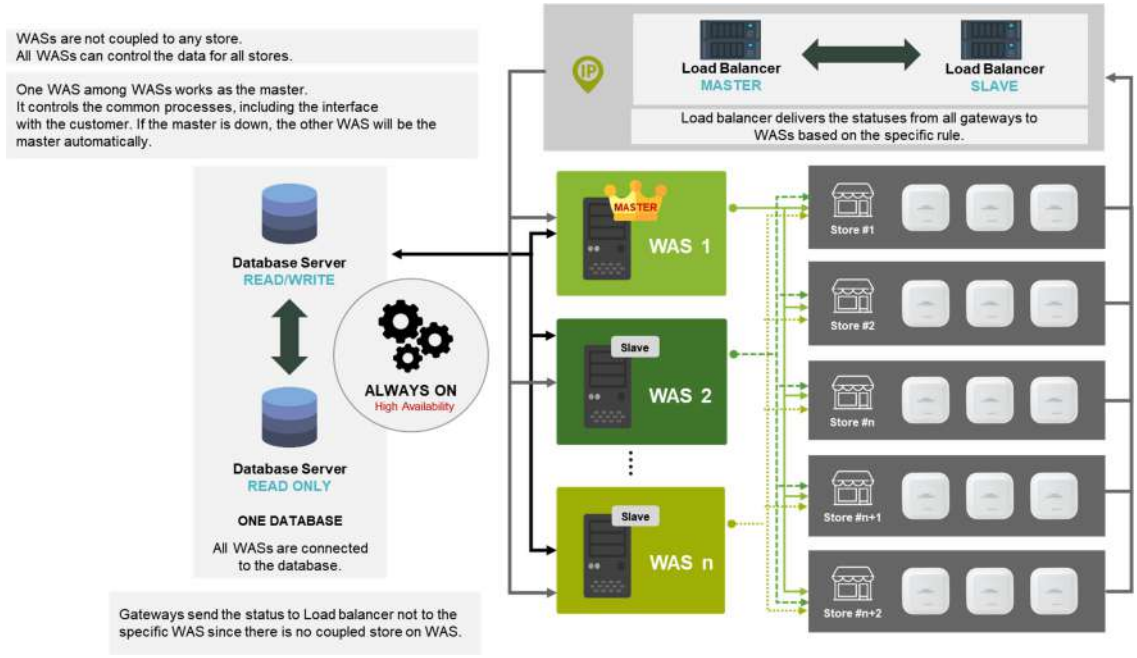
AIMS Layout Designer

AIMS also supports Apache™ FOP (Formatting Objects Processor) for rendering images, providing an opportunity for customers to use this framework to design layouts in the XSL-FO format. As it is an open-source framework, all of the syntaxes supported by standard XSL are also supported by AIMS. Therefore, any complex logic or programmable conditions can easily be implemented using XSL.

Introduction of AIMS+ (Enterprise Solution)

An ESL server deployment plan has been the main topic for the IT departments of retailers. Before the central server was introduced in the market about 5 years ago, the store-based server was the only option for ESL. Previously, there had been a constant demand for a reduced total cost of ownership and better central control, so many ESL vendors developed and introduced their own central server solution into the market. It's true that the central server has more benefits for TCO and central operations, but it has also major drawbacks such as a limitation of scalability and less performance compared to the store-based server. Therefore, because of these limitations (scalability and performance) the

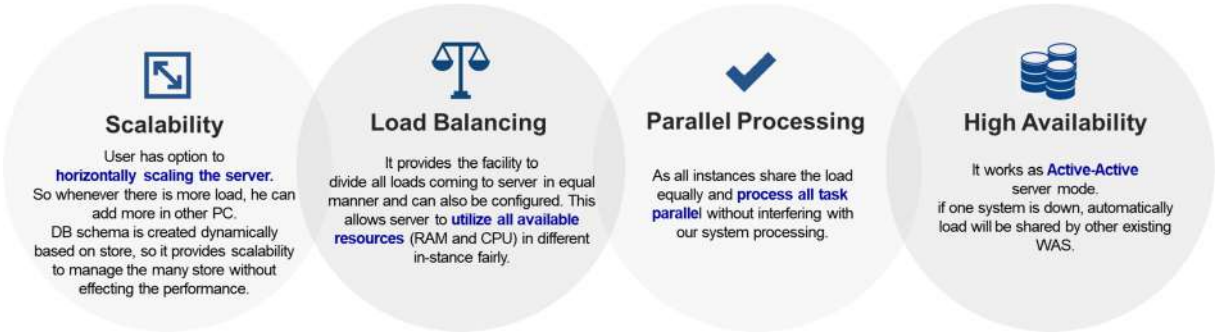
companies that implemented the central solution were also limited to those with a small size format. SoluM had diagnosed this problem for many years and established a development plan to launch the most advanced ESL server platform for a retailer with a large format of store, called AIMS+ (Enterprise).



Architecture of AIMS+ (Enterprise)

The main difference in the architecture is the Load Balancer. Instead of coupling the WAS server (instance of AIMS server) and certain stores, the role of load balancer is to balance the load of requests coming to the WAS servers. Including the load balancing, there are four main features of AIMS+ listed below.

- Scalability, Load-balancing, Parallel processing, High availability



AIMS+ (Enterprise) main features

These four features grant a lot of benefits to a retailer in terms of the flexibility of server deployment, the performance of application server processing and the most efficient total cost of ownership.

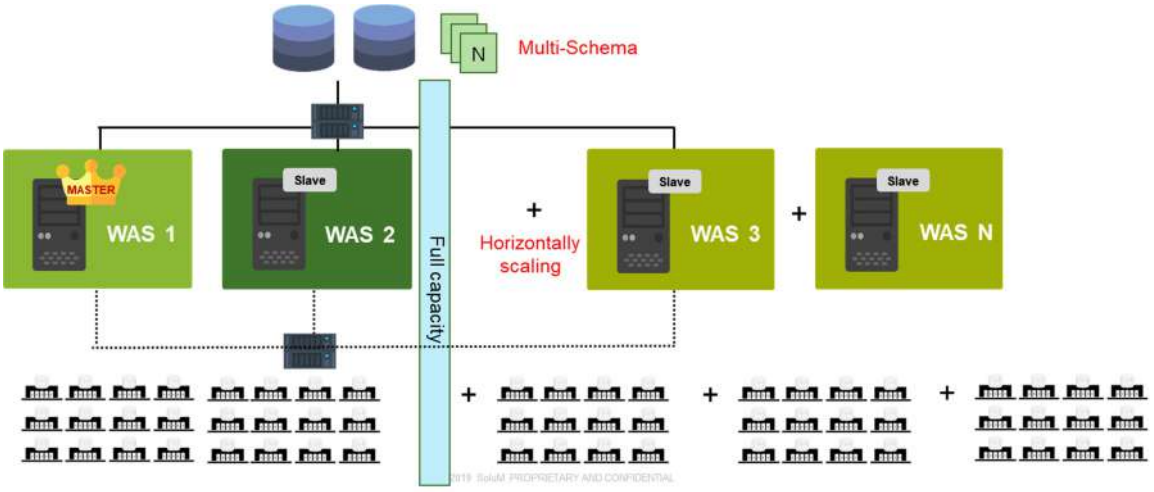
Benefits of AIMS+ (Enterprise Solution)

Scalability

AIMS+ provide scalability at different level. The retailer has the option to horizontally scale the server. So, whenever there is more load, they can add more WAS servers (instance of AIMS server) on other PCs.

AIMS+ follows the Multiple Schema Architecture for DB (databases). When adding a Station (store), AIMS+ will create new schema automatically. The schema naming convention is consisted of the Station ID. It provides us the functionality to horizontally scale based on the number of stores. So, a single DB can be utilized for multiple stores to give better performance.

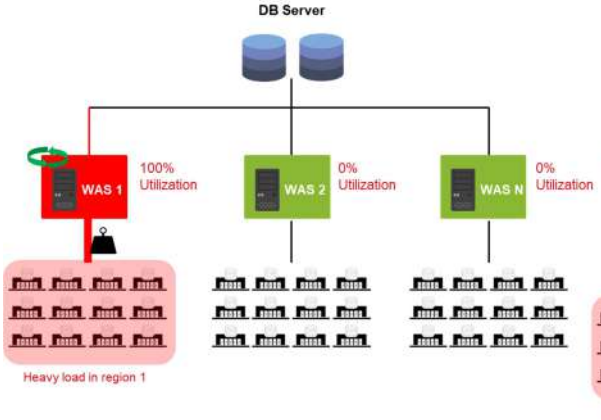
So instead of investing in a big DB/WAS server with high hardware specifications from the beginning to cover all future deployment, the retailer can buy minimum recommended hardware to start with stores for the initial ESL deployment. Within the given server, stores can be added up until the maximum utilization. Afterwards, based on diagnosis and analysis, we can make the decision to add up one more WAS server. With this horizontal scaling, the initial TCO can be minimized in an optimal manner.



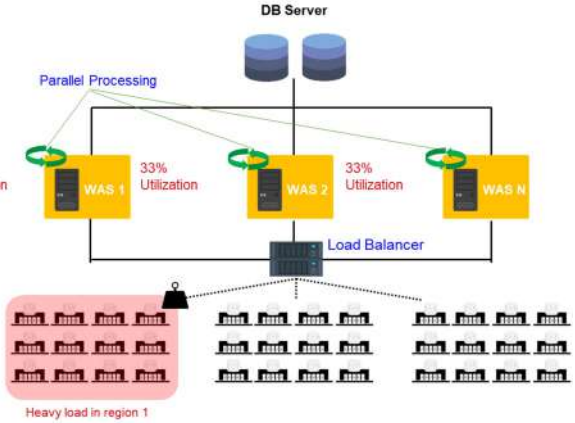
AIMS+ (Enterprise) horizontal scaling

Load Balancing and Parallel Processing

AIMS+ enables the facility to divide all loads coming into server in an equal manner that can also be configured. This allows the server to fairly utilize all available resources (RAM and CPU) in different instances.



Server architecture without load-balancing



AIMS+ with load-balancing

Without load-balancing, when stores are coupled to their specific WAS server and there is a heavy load in a region, only the coupled WAS servers are fully utilized whereas the rest

of the WAS servers aren't utilized. On the other hand, in AIMS+ with load-balancing, when there is a heavy load in a region, all WAS servers are equally and utilized in parallel so that the total processing time is much faster than the previous case.

Performance

When looking at the detailed data and comparing the application processing time between other servers that lack load-balancing and AIMS+ with load-balancing, the outstanding performance of AIMS+ is more obvious. Even without considering the load-balancing and parallel processing, the performance of a single WAS server because of AIMS+ is more than two times better than others (that take 4.5 hours for 470K updates with 1 WAS). This is because all the DB queries are designed for maximum optimization by our own developers instead of using a framework. The parallel processing of AIMS+ makes the application processing time for full scale updates much faster than other servers without parallelization (5 hours for 7.5M updates with 16 WAS).

When we consider the general circumstances of a price update, there is almost no case where all the tags of all stores are updated at the same time. In this regular case when there is a regional update, the benefit of load-balancing and parallel processing becomes tremendously bigger as the load-balancer utilizes all resources for this update. For example, when there are 47K tag updates (10% out of 470K) in one region, then all 16 WAS servers are utilized in parallel, resulting in only 2 minutes of processing time compared to the previous 1-hour figure where only one WAS server was utilized for the region. This is a 30 times faster application processing speed.

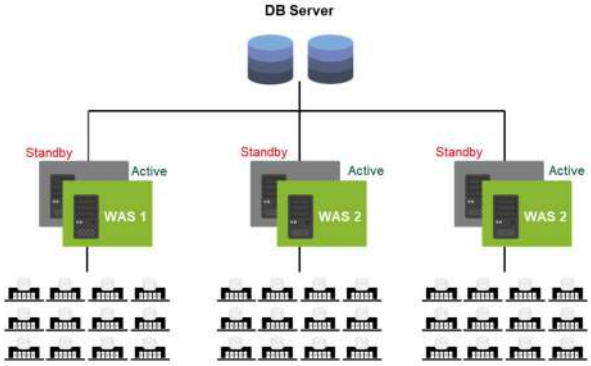
Application processing time WAS Spec: 8 Core, 32 GB, MS SQL	Others without load-balancing	AIMS+ with load-balancing
1 WAS for 470K tag updates (Maximum capability)	10 Hours (1 WAS utilization among 1 WAS)	4.5 Hours (1 WAS utilization among 1 WAS)
16 WAS for 7.5M tag updates (Maximum capability)	12 Hours (16 WAS utilization among 16 WAS)	5 Hours (16 WAS utilization among 16 WAS)
47K tag updates in one region	1 Hour (1 WAS utilization among 16 WAS)	2 Minutes (16 WAS utilization among 16 WAS)
1 store update (26,000 tags)	3 Minutes (1 WAS utilization among 16 WAS)	7 Seconds (16 WAS utilization among 16 WAS)

Performance comparison between others and AIMS+

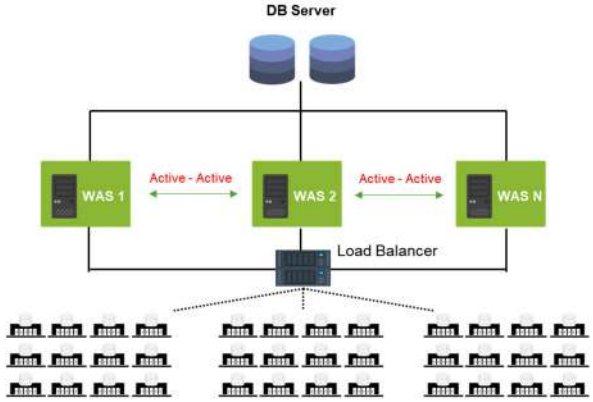
*The data of others comes from the AIMS central server (without the architecture of load-balancing and parallel processing)

High Availability

AIMS+ works in the ACTIVE-ACTIVE server mode. So, there is no need for (passive) backup AIMS servers. If one server goes down, automatically the load will be shared by the other existing WAS. This gives a lot of benefits for the TCO. In server architectures without load-balancing, in order to achieve high availability, standby servers (passive) are always needed. Thus, the TCO has to be doubled. On the other hand, in AIMS+ there is no need for a standby server as all others act as ACTIVE-ACTIVE mode. It's also possible for AIMS+ to be ACTIVE-STANDBY mode but in this case, it needs only one or two standby WAS for the entire system.



Server architecture without load-balancing



AIMS+ with load-balancing

Total Cost of Ownership (in case of Supermarket)

We would like to present the simulation data of the TCO for each different server platform. Please note that this is not an actual figure and it's not a final offer to retailers. This is only to provide you an insight and better understanding on the TCO for different server options. For instance, the data is only for a supermarket covering 26,000 tags per store with 290 stores (total 7.5M tags).

In a short, the Central Server has about four times better TCO benefits compared to the Store Server. However, as previously mentioned, the application processing time of Central Server (without load-balancing) can be slow when there is a heavy load in a region. On the other hand, AIMS+ with load-balancing can be in maximum 30 times faster than a Central Server. Furthermore, in the TCO perspective, AIMS+ has about 30% better and two times better benefits in the case of high availability.

Server	WAS	Load balancer	DB
Store Server	Intel Xeon 8 core 4 GB	N/A	Intel Xeon 8 core 4GB
	Windows, Linux (CentOS, etc)	N/A	MS SQL (or Postgres)
	100G HDD	N/A	100 GB HDD
Central Server or AIMS+ (Enterprise)	Intel Xeon 16 core 32 GB	Intel Xeon 8 core 16GB	Intel Xeon 64 core 128GB
	Windows, Linux (CentOS, etc)	Windows, Linux (CentOS, etc)	MS SQL (or Postgres)
	500G HDD	200G HDD	2 TB HDD

Server specification of different server platform (recommended)

Hardware Requirement	Store server	Central Server	AIMS+ (Enterprise)
18 stores, 470K tags	18 DB, 18 WAS	1 DB, 1 WAS	1 DB, 1 WAS

18 stores, 470K tags With High Availability	36 DB, 36 WAS	2 DB, 2 WAS	2 DB, 2 WAS
290 stores, 7.5M tags	290 DB, 290 WAS	1 DB, 16 WAS	1 DB, 12 WAS, 2 LB
290 stores, 7.5M tags with High Availability	580 DB, 580 WAS (Active-Standby)	2 DB, 32 WAS (Active-Standby)	2 DB, 13 WAS, 2 LB (8 Active-Active) (1 Active/Passive-optional)

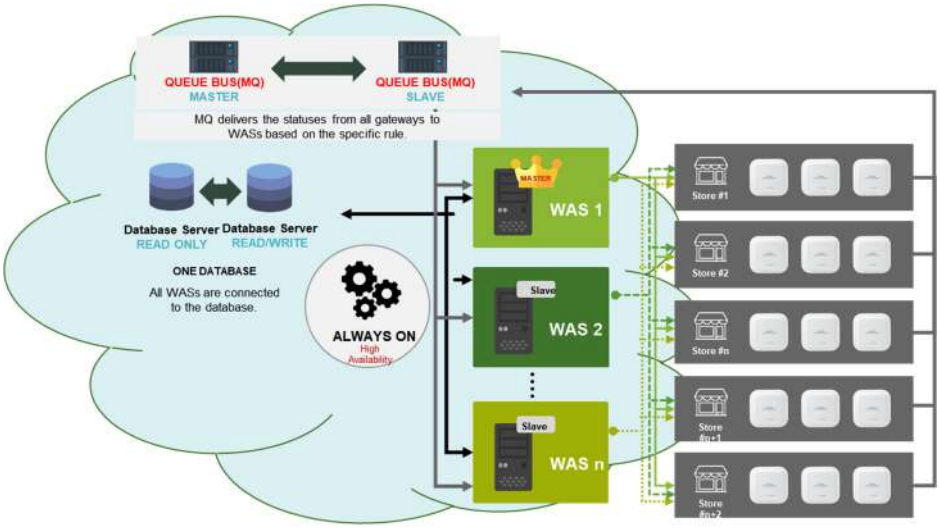
Server hardware requirement (recommended)

TCO	Store server	Central Server	AIMS+ (Enterprise)
290 stores, 7.5M tags	~145,000	~35,200	~27,700
290 stores, 7.5M tags with High Availability	~290,000	~70,400	~32,900

Server hardware TCO comparison (simulation)

SaaS AIMS+ Cloud

SoluM is able to provide a SaaS AIMS+ Cloud service with our own private cloud server. All the benefits of AIMS+ (Scalability, Load-balancing/Parallel processing and High Availability) remain the same in the SaaS Cloud service. SoluM will charge retailers with a very competitive pricing model (additional €100 ~ €150 / store, varied based on the deployment plan)



AIMS+ Cloud architecture

Security of AIMS+ / Cloud

This is the security information of AIMS+ and AIMS+ Cloud.

Data structure / recovery

The DB schema has divisions between each store. One store data can't alter or corrupt the other store data. With proper DB backups, we can restore the data back to a previously stored point.

Backup

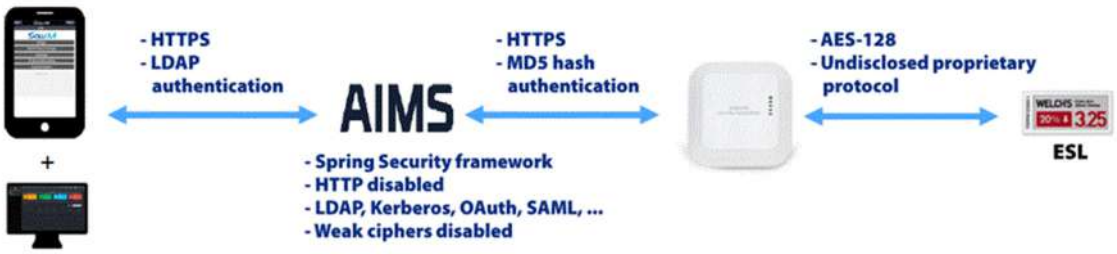
Mirroring (Backing up) the DB server can easily be configured on a schedule where it can later be used for data recovery.

User authentication

AIMS+ will provide API-Gateway based authentication and authorization. So, all requests coming into the servers can be easily be authenticated with our security service. We also provide a user management functionality in order to restrict user operations according to their role-based access permissions.

Disaster recovery

AIMS+ provides disaster recovery using its scalable Active-Active design. As the AIMS monitoring service (CS) watches the health of each WAS and it identifies that a WAS is offline due to some failure, all the load of that WAS will be diverted to other WAS instances.



Security information of AIMS

B. Gateways

SOLUM is proud to say that we have renewed the Gateway for our newest Newton product line-up.

The Newton Gateway supports two-way communication between itself and ESLs. It has excellent communication distance which translates to savings on infrastructure cost and does not require installation of a master hub. A bracket accessory is also provided for easy installation. Supports both 2.4GHz and 900MHz.

NEWTON USB-Gateway

We also put into consideration for our clients the cost efficiency of a small-scale ESL implementation.

Instead of installing the Gateway in the ceiling and setting up cables, the USB-Gateway can be connected to your computers or even right in the WIFI access point. The Gateway itself has a 5K label capacity and is already systematically integrated with the world's leading WIFI access point provider (Aruba, ExtreamNetworks and Samsung).

NEWTON Gateway NEWTON USB Gateway

C. Support contract/service contract

SOLUM only works with reliable third-party vendors whom we then recommend to the clients for the installations.

3rd level support – remote session, ex. why this gateway cannot be accessed, we ask them for their log files where we can check on our own laptops, so we can see what is going on and we can help them

Steps for Assimilation

Pilot store implementation is when a client orders for SOLUM's electronic shelf labels to be rolled out to only one section of a store or one branch of a franchise. During this procedure, the client tests the reaction of their target market to the new ESLs and get valuable feedback to make the eventual rollout to the entire store or to more branches go more smoothly.
The pilot store implementation is assisted by SOLUM engineers, and transition stage is from half a year up to 2 years.

Product Specifications

DIMENSION (mm)	36.7 × 45.0 × 13.1
ACTIVE DISPLAY AREA (mm)	27.0 × 27.0
RESOLUTION (Pixel)	200 × 200
PIXEL DENSITY	184 dpi
DISPLAY TECHNOLOGY	Full Graphic E-ink Display
PIXEL COLORS	BW / BWR / BWY
VIEWING ANGLE	Nearly 180°
USABLE PAGES	Up to 7 pages
OPERATING TEMPERATURE	0 ~ 40℃
BATTERY	CR2450 × 1ea
BATTERY LIFETIME	Up To 10 years (2 Update/day)
ENCRYPTION	128-Bit AES
COMPLIANCE	CE, RoHS, FCC
NFC	FeliCa NFC Forum Type 3
WATERPROOF	IP67
BUTTON	2 Buttons
LED	7 Colors (Red/Green/Blue/Yellow/Cyan/Magenta/White)
ESL OPERATING FREQUENCY	2.4 ~ 2.480 Ghz
WIRELESS FIRMWARE UPDATE	Yes

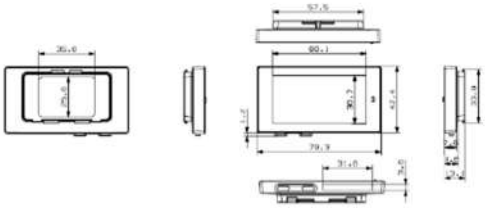
Newton

2.2inch

DIMENSION (mm)	67.1 × 37.4 × 13.1
ACTIVE DISPLAY AREA (mm)	48.1 × 26.0
RESOLUTION (Pixel)	296 × 160
PIXEL DENSITY	156 dpi
DISPLAY TECHNOLOGY	Full Graphic E-ink Display
PIXEL COLORS	STANDARD MODEL : BW / BWR / BWY
	FREEZER MODEL : BW
VIEWING ANGLE	Nearly 180°
USABLE PAGES	Up to 7 pages
OPERATING TEMPERATURE	STANDARD MODEL : 0 ~ 40℃
	FREEZER MODEL : -25℃ ~ 0℃
BATTERY	CR2450 × 2ea
BATTERY LIFETIME	Up To 10 years (2 Update/day)
ENCRYPTION	128-Bit AES
COMPLIANCE	CE, RoHS, FCC
NFC	FeliCa NFC Forum Type 3
WATERPROOF	IP67
BUTTON	2 Buttons
LED	7 Colors (Red/Green/Blue/Yellow/Cyan/Magenta/White)
ESL OPERATING FREQUENCY	2.4 ~ 2.480 Ghz
WIRELESS FIRMWARE UPDATE	Yes

Newton

2.6inch



DIMENSION (mm)	79.3 × 42.4 × 13.1
ACTIVE DISPLAY AREA (mm)	60.1 × 30.7
RESOLUTION (Pixel)	360 × 184
PIXEL DENSITY	152 dpi
DISPLAY TECHNOLOGY	Full Graphic E-ink Display
PIXEL COLORS	STANDARD MODEL : BW / BWR / BWY
	FREEZER MODEL : BW
VIEWING ANGLE	Nearly 180°
USABLE PAGES	Up to 7 pages
OPERATING TEMPERATURE	STANDARD MODEL : 0 ~ 40℃
	FREEZER MODEL : -25℃ ~ 0℃
BATTERY	CR2450 × 2ea
BATTERY LIFETIME	Up To 10 years (2 Update/day)
ENCRYPTION	128-Bit AES
COMPLIANCE	CE, RoHS, FCC
NFC	FeliCa NFC Forum Type 3
WATERPROOF	IP67
BUTTON	2 Buttons
LED	7 Colors (Red/Green/Blue/Yellow/Cyan/Magenta/White)
ESL OPERATING FREQUENCY	2.4 ~ 2.480 Ghz
WIRELESS FIRMWARE UPDATE	Yes

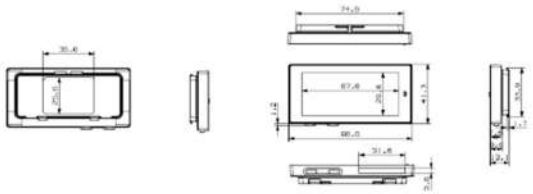
Newton

2.7inch

DIMENSION (mm)	76.0 × 49.5 × 13.1
ACTIVE DISPLAY AREA (mm)	57.3 × 38.1
RESOLUTION (Pixel)	300 × 200
PIXEL DENSITY	133 dpi
DISPLAY TECHNOLOGY	Full Graphic E-ink Display
PIXEL COLORS	BW / BWR / BWY
VIEWING ANGLE	Nearly 180°
USABLE PAGES	Up to 7 pages
OPERATING TEMPERATURE	0 ~ 40℃
BATTERY	CR2450 × 2ea
BATTERY LIFETIME	Up To 10 years (2 Update/day)
ENCRYPTION	128-Bit AES
COMPLIANCE	CE, RoHS, FCC
NFC	FeliCa NFC Forum Type 3
WATERPROOF	IP67
BUTTON	2 Buttons
LED	7 Colors (Red/Green/Blue/Yellow/Cyan/Magenta/White)
ESL OPERATING FREQUENCY	2.4 ~ 2.480 Ghz
WIRELESS FIRMWARE UPDATE	Yes

Newton

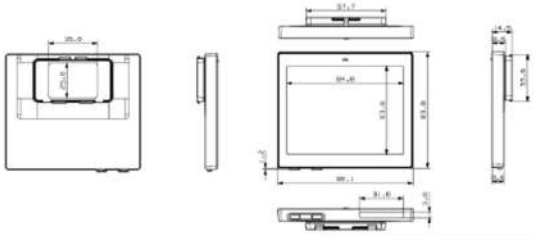
2.9inch



DIMENSION (mm)	86.0 × 41.3 × 13.1
ACTIVE DISPLAY AREA (mm)	67.6 × 29.6
RESOLUTION (Pixel)	384 × 168
PIXEL DENSITY	144 dpi
DISPLAY TECHNOLOGY	Full Graphic E-ink Display
PIXEL COLORS	STANDARD MODEL : BW / BWR / BWY
	FREEZER MODEL : BW
VIEWING ANGLE	Nearly 180°
USABLE PAGES	Up to 7 pages
OPERATING TEMPERATURE	STANDARD MODEL : 0 ~ 40℃
	FREEZER MODEL : -25℃ ~ 0℃
BATTERY	CR2450 × 2ea
BATTERY LIFETIME	Up To 10 years (2 Update/day)
ENCRYPTION	128-Bit AES
COMPLIANCE	CE, RoHS, FCC
NFC	FeliCa NFC Forum Type 3
WATERPROOF	IP67
BUTTON	2 Buttons
LED	7 Colors (Red/Green/Blue/Yellow/Cyan/Magenta/White)
ESL OPERATING FREQUENCY	2.4 ~ 2.480 Ghz
WIRELESS FIRMWARE UPDATE	Yes

Newton

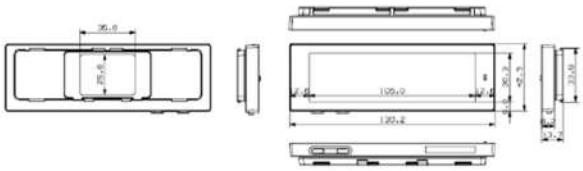
4.2inch



DIMENSION (mm)	98.1 × 83.8 × 14.5
ACTIVE DISPLAY AREA (mm)	84.8 × 63.6
RESOLUTION (Pixel)	400 × 300
PIXEL DENSITY	120 dpi
DISPLAY TECHNOLOGY	Full Graphic E-ink Display
PIXEL COLORS	BW / BWR / BWY
VIEWING ANGLE	Nearly 180°
USABLE PAGES	Up to 7 pages
OPERATING TEMPERATURE	0 ~ 40℃
BATTERY	CR2450 × 2ea
BATTERY LIFETIME	Up To 10 years (2 Update/day)
ENCRYPTION	128-Bit AES
COMPLIANCE	CE, RoHS, FCC
NFC	FeliCa NFC Forum Type 3
WATERPROOF	IP67
BUTTON	2 Buttons
LED	7 Colors (Red/Green/Blue/Yellow/Cyan/Magenta/White)
ESL OPERATING FREQUENCY	2.4 ~ 2.480 Ghz
WIRELESS FIRMWARE UPDATE	Yes

Newton

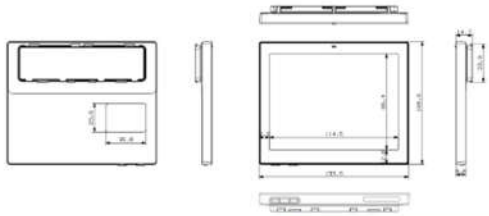
4.3inch



DIMENSION (mm)	130.3 × 42.4 × 13.9
ACTIVE DISPLAY AREA (mm)	105.4 × 30.7
RESOLUTION (Pixel)	522 × 152
PIXEL DENSITY	125 dpi
DISPLAY TECHNOLOGY	Full Graphic E-ink Display
PIXEL COLORS	BW / BWR / BWY
VIEWING ANGLE	Nearly 180°
USABLE PAGES	Up to 7 pages
OPERATING TEMPERATURE	0 ~ 40℃
BATTERY	CR2450 × 2ea
BATTERY LIFETIME	Up To 10 years (2 Update/day)
ENCRYPTION	128-Bit AES
COMPLIANCE	CE, RoHS, FCC
NFC	FeliCa NFC Forum Type 3
WATERPROOF	IP67
BUTTON	2 Buttons
LED	7 Colors (Red/Green/Blue/Yellow/Cyan/Magenta/White)
ESL OPERATING FREQUENCY	2.4 ~ 2.480 Ghz
WIRELESS FIRMWARE UPDATE	Yes

Newton

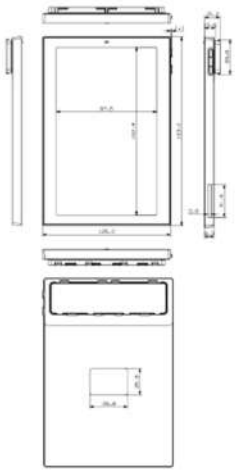
6.0inch



DIMENSION (mm)	133.0 × 109.0 × 14.7
ACTIVE DISPLAY AREA (mm)	114.9 × 85.8
RESOLUTION (Pixel)	600 × 448
PIXEL DENSITY	132 dpi
DISPLAY TECHNOLOGY	Full Graphic E-ink Display
PIXEL COLORS	BW / BWR / BWY
VIEWING ANGLE	Nearly 180°
USABLE PAGES	Up to 7 pages
OPERATING TEMPERATURE	0 ~ 40℃
BATTERY	CR2450 × 4ea
BATTERY LIFETIME	Up To 10 years (2 Update/day)
ENCRYPTION	128-Bit AES
COMPLIANCE	CE, RoHS, FCC
NFC	FeliCa NFC Forum Type 3
WATERPROOF	IP67
BUTTON	2 Buttons
LED	7 Colors (Red/Green/Blue/Yellow/Cyan/Magenta/White)
ESL OPERATING FREQUENCY	2.4 ~ 2.480 Ghz
WIRELESS FIRMWARE UPDATE	Yes

Newton

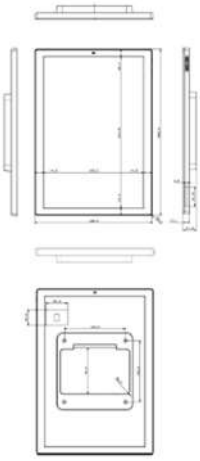
7.5inch



DIMENSION (mm)	125.0 × 183.0 × 15.2
ACTIVE DISPLAY AREA (mm)	163.2 × 97.9
RESOLUTION (Pixel)	880 × 528
PIXEL DENSITY	126 dpi
DISPLAY TECHNOLOGY	Full Graphic E-ink Display
PIXEL COLORS	BW / BWR
VIEWING ANGLE	Nearly 180°
USABLE PAGES	Up to 7 pages
OPERATING TEMPERATURE	0 ~ 40℃
BATTERY	CR2450 × 4ea
BATTERY LIFETIME	Up To 10 years (2 Update/day)
ENCRYPTION	128-Bit AES
COMPLIANCE	CE, RoHS, FCC
NFC	FeliCa NFC Forum Type 3
WATERPROOF	IP67
BUTTON	2 Buttons
LED	7 Colors (Red/Green/Blue/Yellow/Cyan/Magenta/White)
ESL OPERATING FREQUENCY	2.4 ~ 2.480 Ghz
WIRELESS FIRMWARE UPDATE	Yes

Newton

11.6inch



DIMENSION (mm)	192.0 × 269.3 × 21.9
ACTIVE DISPLAY AREA (mm)	163.0 × 244.5
RESOLUTION (Pixel)	640 × 960
PIXEL DENSITY	100 dpi
DISPLAY TECHNOLOGY	Full Graphic E-ink Display
PIXEL COLORS	BW / BWR
VIEWING ANGLE	Nearly 180°
USABLE PAGES	Up to 7 pages
OPERATING TEMPERATURE	0 ~ 40°C
BATTERY	AA × 4ea
BATTERY LIFETIME	Up To 10 years (2 Update/day)
ENCRYPTION	128-Bit AES
COMPLIANCE	CE, RoHS, FCC
NFC	FeliCa NFC Forum Type 3
WATERPROOF	IP67
BUTTON	2 Buttons
LED	7 Colors (Red/Green/Blue/Yellow/Cyan/Magenta/White)
ESL OPERATING FREQUENCY	2.4 ~ 2.480 Ghz
WIRELESS FIRMWARE UPDATE	Yes

Off-functions (booting)

As we've mentioned earlier, NEWTON has two buttons. By pressing these two buttons, the label turns on and off. Now, you can turn it on when the tags arrive into a store and turn it off when it's not used. This gives a lot of benefits to a store associate in comparison to the current methodology, which is using a PDA to scan a tag and press the off function from the device. Pressing the label buttons is a much easier and faster procedure. Good management of turning on/off a tag is important for the following two reasons. First, it allows you to save energy and therefore extend the battery life. Second, it helps to keep the ESL status data be more accurate. A tag stored in a back room without deactivation gives false data to the ESL server, which can lead to confusion about the ESL status data of a store.

Installation / deinstallation

Installation and removal have never been easier with NEWTON's easy locking system. Just use your own two hands to install the tag and then use a remover tool to detach a tag from the shelves within a single action. The tag cannot be easily detached from the self by anyone with their bare hands.

Battery Replacement

The battery replacement of NEWTON is easy and simple. The batteries are held underneath the battery cover, which just needs a leverage tool to be opened up from its hook. SoluM can provide the battery pack (battery cover and batteries together), which makes the replacement work much easier. Instead of replacing each individual battery one by one, only one battery pack just needs to be replaced.

The battery packs can bring a big benefit to the RMA procedure. Instead of the retailer sending a whole tag to the RMA center, SoluM can deliver battery packs, which can be easily replaced by a store associate. This can reduce the whole RMA processing time of and cost. The constant LED indicators before/after/during store hour can also help to easily detect a tag with low battery.

The battery pack of NEWTON

Replacing with battery packs can provide a much safer disposal method of used battery cells. This is because when store associates collect used battery cells, despite the guidelines for proper disposal, there are many dangerous cases that associates place all the cells within the same container, which can build up enough heat to make a cell explode. On the other hand, even though it is not proper procedure, putting our battery packs in the same container cannot cause cell explosions as the cases prevent the cells from direct contact with each other. The best and safest method is always putting the battery packs in a proper layer container.

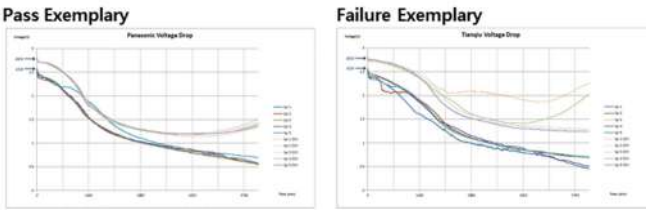
Example of dangerous treatment

Example of battery pack treatment

Battery Quality

SoluM maintains great quality assurance of our batteries. The authorized battery companies by SoluM are Panasonic, Bexel and Mitsubishi, which have passed the strictest reliability test of the SoluM quality assurance team. There are two parts of the SoluM battery authorization test. 1. Reliability test. 2. Performance under discharging. The company that passes both of the tests is authorized to be used in SoluM ESL.
SoluM battery authorization test passed company: Panasonic, Bexel and Mitsubishi
SoluM battery authorization test failed company: Tianqiu, Henlimax, Lidea, Kemix, WinPow and Omergy

Failure example of leaking in reliability test



Example of pass/fail in voltage drop test

References

Loblaw

Loblaw, the No.1 retailer in Canada, which has over 3,800 stores with 9 different banners, started to implement SOLUM ESL solution with AIMS Central Server back in Dec 2018.

The reason Loblaw chose SOLUM as a strategic partner is that we proved that it was the best Central Server architecture (AIMS) in a PoC test comparison among three major ESL vendors.

Metro C&C

Starting from 2015, Metro C&C has deployed 6 million SOLUM ESLs into over 229 stores in 14 different countries (Europe and Asia). They have been satisfied with SOLUM not only because of our performance and quality of ESL tags, but also our global service capability. SOLUM provides support to the Metro C&C IT department for the interface, layout design, installation, and RMA service for the ESL implementation in all 14 countries.

Macy's

Over the last 3 years, Macy's, one of the top department stores, has adopted SOLUM ESLs across 540 stores. It was the first rollout project in the department store and fashion industry with Item Labels.
At the end of 2017, SOLUM's design team worked with the Macy's team to produce a vast line-up of designs for their different needs (in the shoes and home goods section), that was ultimately narrowed down to 3 specific new designs. SOLUM was able to expedite the design, development, and manufacturing of 500,000 ESLs within 3 months to meet Macy's target timeline. All this was possible because SOLUM has in-house capabilities in design and production.

SOLUM has continually been designing and developing new designs until now for Macy's in order to implement another new section of products. For tag management, SOLUM provided the AIMS Central Server allowing Macy's centralize tag up-dates and pricing from a single location, helping save on infrastructure costs. Although Macy's has been satisfied with AIMS, they are in the migration process from AIMS to AIMS+ for all 540 stores. This is because they plan to expand their ESL deployment across all sections of their departments and have evaluated that the AIMS+ would be the best platform for performance and scalability.

Alibaba

Alibaba has been expanding their own offline stores and building up their ecosystem using Ali-Pay together with multiple retailers. In early 2019, SoluM was selected as the ESL solution provider for Alibaba for the upcoming 6 million tags deal. SoluM was the only ESL provider who could meet their special requirements to develop completely new tags that can communicate with Alibaba's server and gateway protocol, as we have an internal R&D team to design and develop a communication protocol on our own.

Sephora Korea (South)

Sephora has opened its first flagship store in Seoul, Korea and was the first adopter of SoluM Newton in history. As one of the most important strategic partners in Korea, Sephora happily agreed to take the opportunity to be a first pilot customer for NEWTON to evaluate its great value in design, performance and various possibilities with LEDs, buttons and real-time speed. The SoluM R&D team has great confidence in the quality of this new developed product and will officially announce the global launch of NEWTON after the successful pilot results in next 2~3 months.

What's Next

Since 2015, SOLUM has been furthering the electronic shelf label technological landscape, and helping future-proof businesses along the way. We have delivered more than 7 million tags to over 300 stores and has an on-going plan to deliver 600K~1M tags every month. This is the biggest Graphical ESL rollout project that has ever happened in history.

And we're not stopping there.

Newton is the cornerstone by which all shelf-edge innovations will be built. We've proven through our creation of Newton that we are more than capable of leading the charge in the electronic shelf labels industry. In the years to come, SOLUM will continue to innovate, evolve, and create fully integrated, in-house solutions for every business need.