The L Squared Hub—
Our Technology

1. The L Squared Hub – Our Technology

The L Squared Hub is an enterprise grade cloud-based software solution that has been deployed in large enterprise customers across the world for over a decade.

The L Squared Hub is built using Microsoft Azure cloud infrastructure and as a result has all the enterprise security, monitoring, robustness, and uptime guarantees provided by Microsoft.

In this section we will identify and explain the features of the platform that is relevant to you.

1.1 Relevant Features

1.1.1 Intuitive Web Interface

The L Squared Hub's web interface is intuitive, designed from ground up to be usable with just one hour of training. The web interface is designed to provide a desktop like application experience with quick responses, fast search and drag and drop functionality.
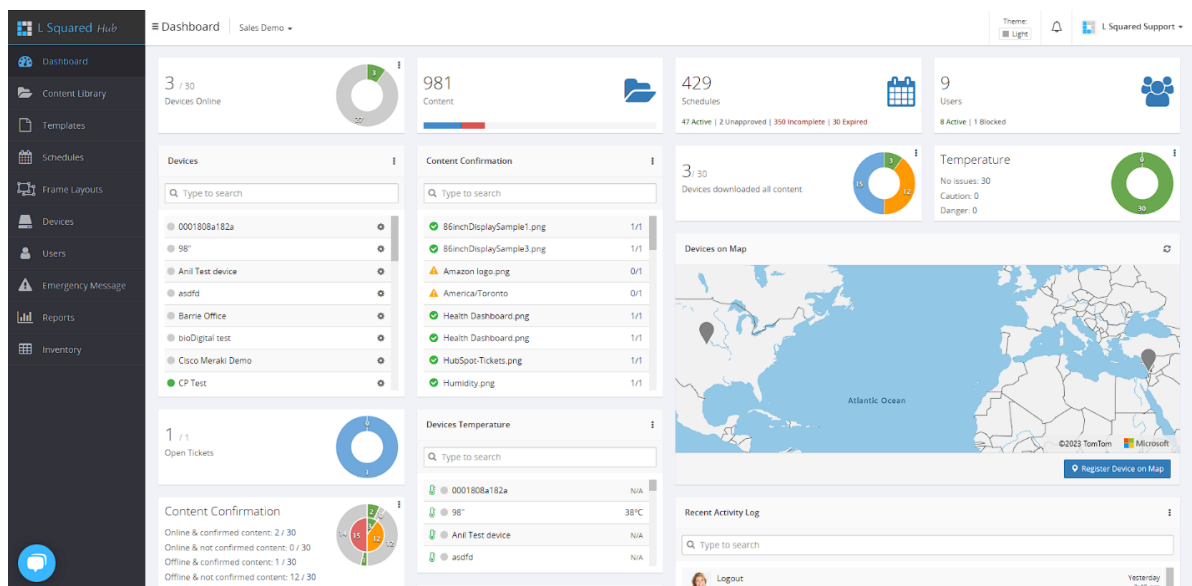

Figure 1: Screenshot of the dashboard showing the modern look and feel of our platform

1.1.2 Easy to Use Content Library

The purpose of the content library is to store and manage the content that users will be publishing to the displays. The content library is where all the images, videos, widgets, plugins and everything else that will eventually be displayed on the screens will be store.

The content library in the L Squared hub is designed to be like Microsoft Windows Explorer with similar folder, permissions, structure, and commands. A user familiar with Microsoft Windows or MAC operating system can intuitively start using the L Squared Hub content library with little to no training.

The content library supports the separation of files by groups so that only certain users will be able to see certain folders and files.

It also supports workflow so that content uploaded by users with restricted access requires approval before it can be published to the displays.
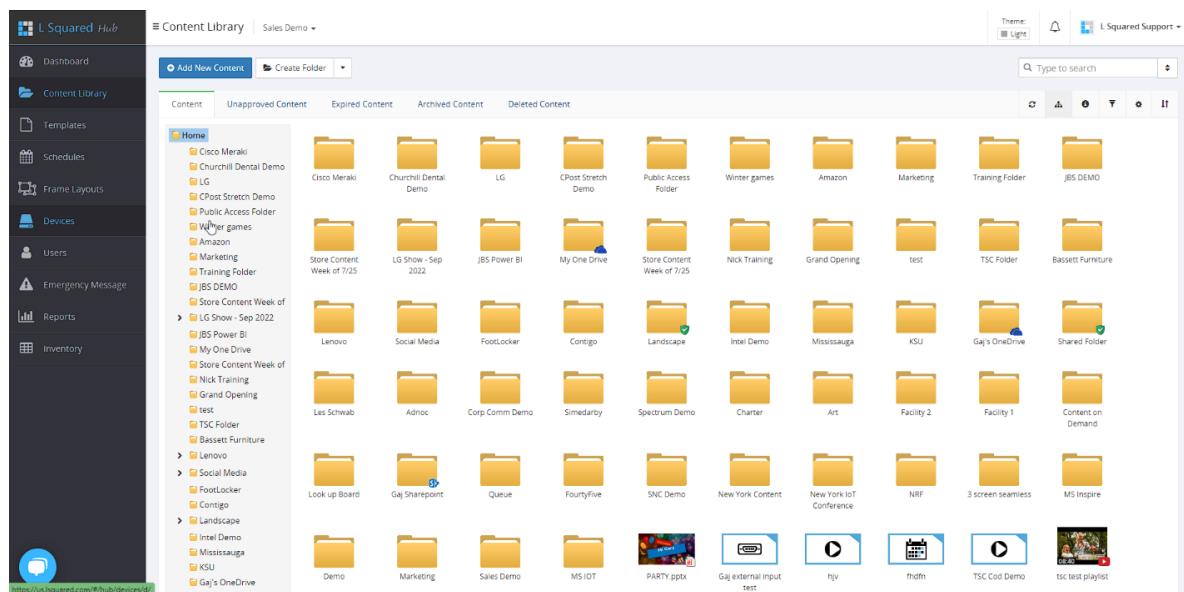

Figure 2: Screenshot of the L Squared Hub's content library

1.1.3 Rule Based Scheduling

The L Squared Hub utilizes a rule-based scheduler for publishing content onto the displays. Once the content is in the content library, a user can simply create a schedule using the schedule wizard. The schedule wizard takes the user through five steps that allows the user to define which contents to play on which displays, and when to play them. There are many different options for advanced users to select exactly the duration, the displays (one or many) and exactly when to play even starting and stopping within a particular day or day of the week, particular times within a day etc.
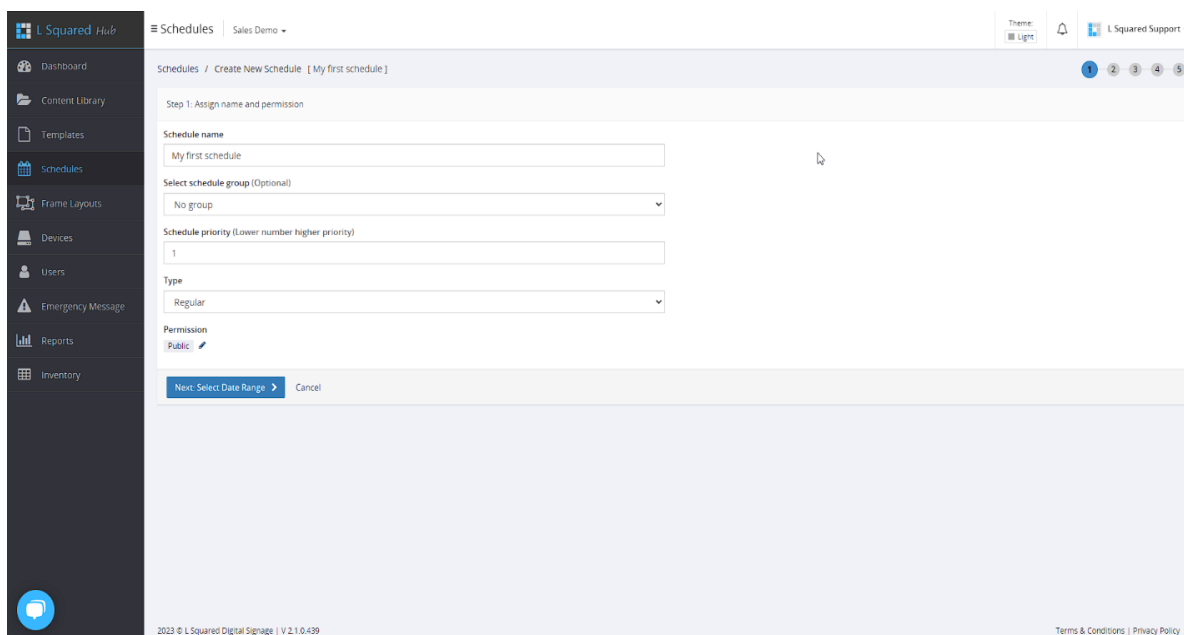

Figure 3: Screenshot showing the first step of the five step schedule wizard

The rule-based scheduling system avoids the need for creating playlist. The rules set but the user during the scheduling process is used to automatically create the playlists that are used by each display.

The various scheduling options allow users to finely target specific content to single display or multiple displays easily.

In addition, schedules can be created that can override normal programmed content. This is often used if there is a special event occurring or if a live stream needs to start at specific time. Schedule override function can be used to pause currently programmed content, to play a specific schedule then revert back to regularly playing content when the schedule is finished.

1.1.4 Robust Dashboard

The dashboard is the first screen shown when a user logs in. It is completely customizable to the user's preferences showing exactly the information that each type user needs and in the order they want to see it.

Dashboard shows, at a glance, everything a user or administrator needs in order to understand the health of the displays, status of schedules, locations and status of the screens, user actions and much more. The dashboard is interactive and allows for user to drill down to get more information or export them as reports.
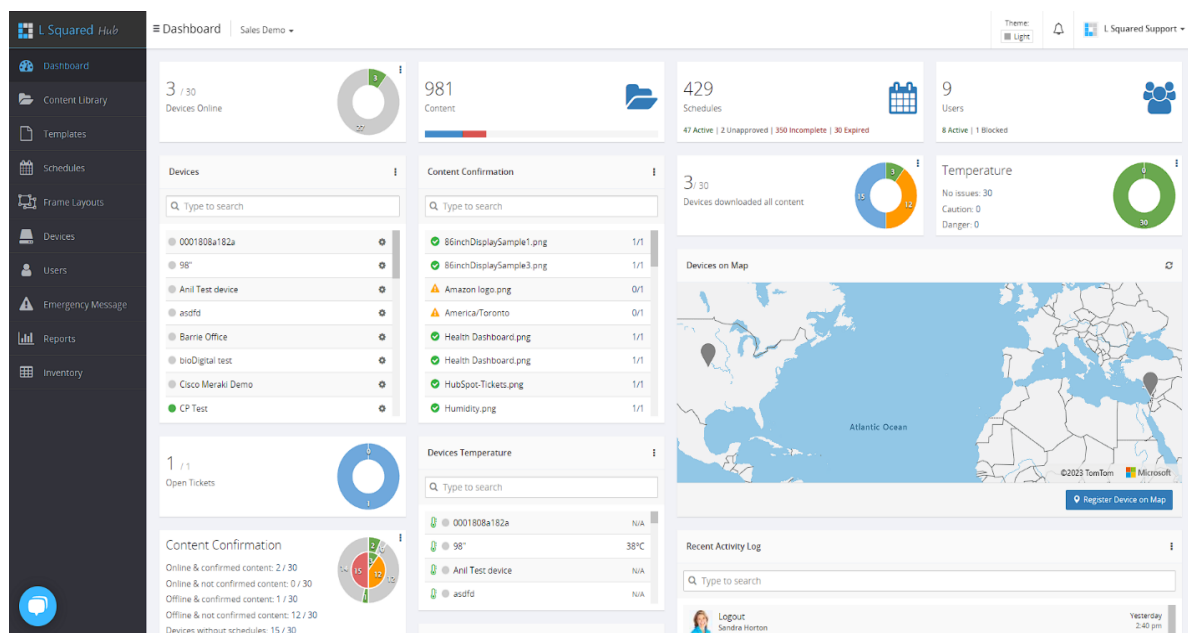

Figure 4: Screenshot showing the dashboard of the L Squared Hub

1.1.5 Reporting

The reporting engine provides wide variety of reports including reports to monetize the digital signage network such as proof of play, as well as reports about the health of the network over time.

There are many other reports including: Content Confirmation, Inventory, Device Status, On/Off history and much more. Custom reports can also be created with other data that is available in the database and the reports can scheduled to be emailed to users as needed.
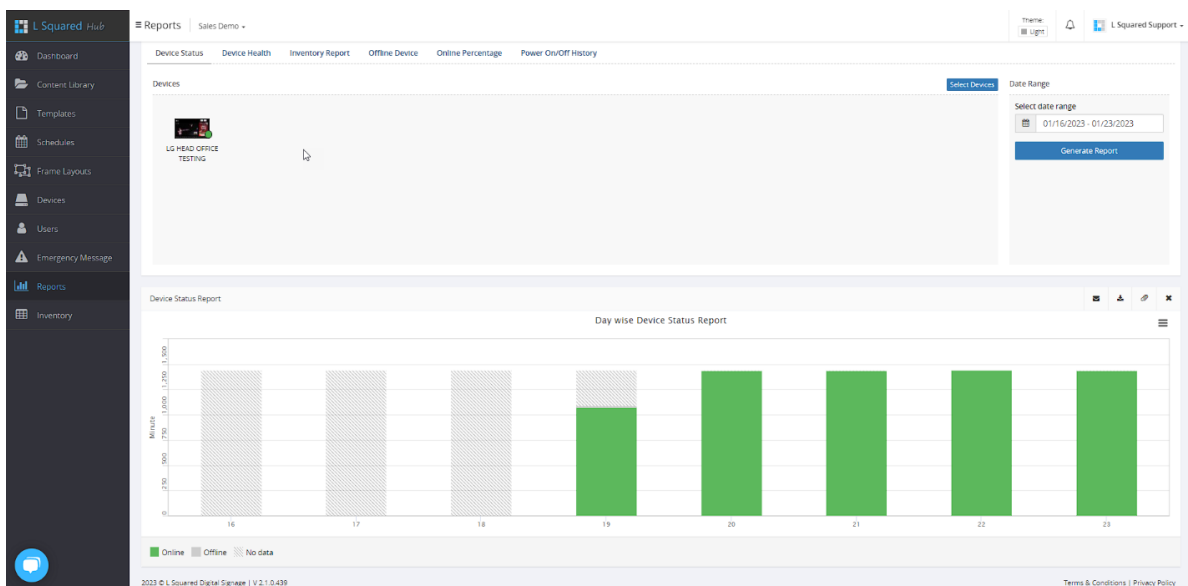
Figure 5: Screenshot showing one of the many reports available in the Hub. These reports can be downloaded as excel file also.

1.1.6 Alerting

The L Squared hub supports a robust alerting system. Every user has the option to register to receive alerts for many events. These events include: when new content is uploaded, when content is deleted, when content is change, when devices go offline, when schedules are created etc. There are many events that users can register to receive an email notification for. List of events is shown in the picture below.
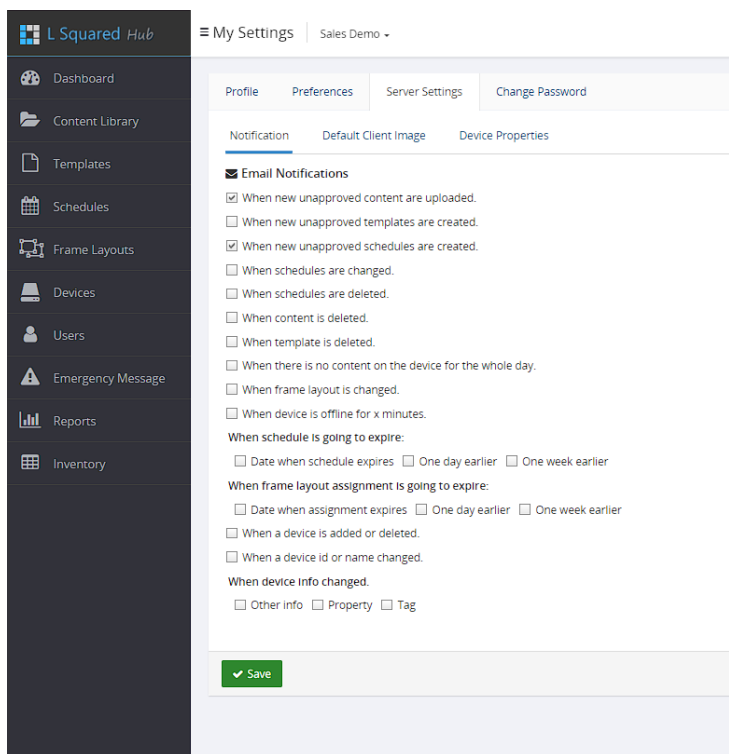

Figure 6: Screenshot showing the alerts available in the L Squared Hub

1.1.7 Targeting Screens Using Tags

The L Squared Hub supports tagging displays. This allows for user to create tags for categorization and specific use cases. The tags can be combined to finely target the network with exactly the content that is required.

For example, a user can create a tag called "Georgia", "USA", "Front Window", "Drive Through", "Cashier TV1", "Cashier TV2". These tags are then assigned to the appropriate displays. During scheduling, the user can utilize these tags to finely target the network with the content.

During the schedule step, a user can use tags to target USA, and Drive Through, Excluding Georgia. This will send the content to all displays that have the tag USA and Drive through and exclude the displays in Georgia. The combinations of tags allow for a powerful targeting mechanism that is intuitive to use. In addition this allows for easier management of displays because when displays are installed or changed, they just need to have the correct tags assigned in order to download the right schedules and content.
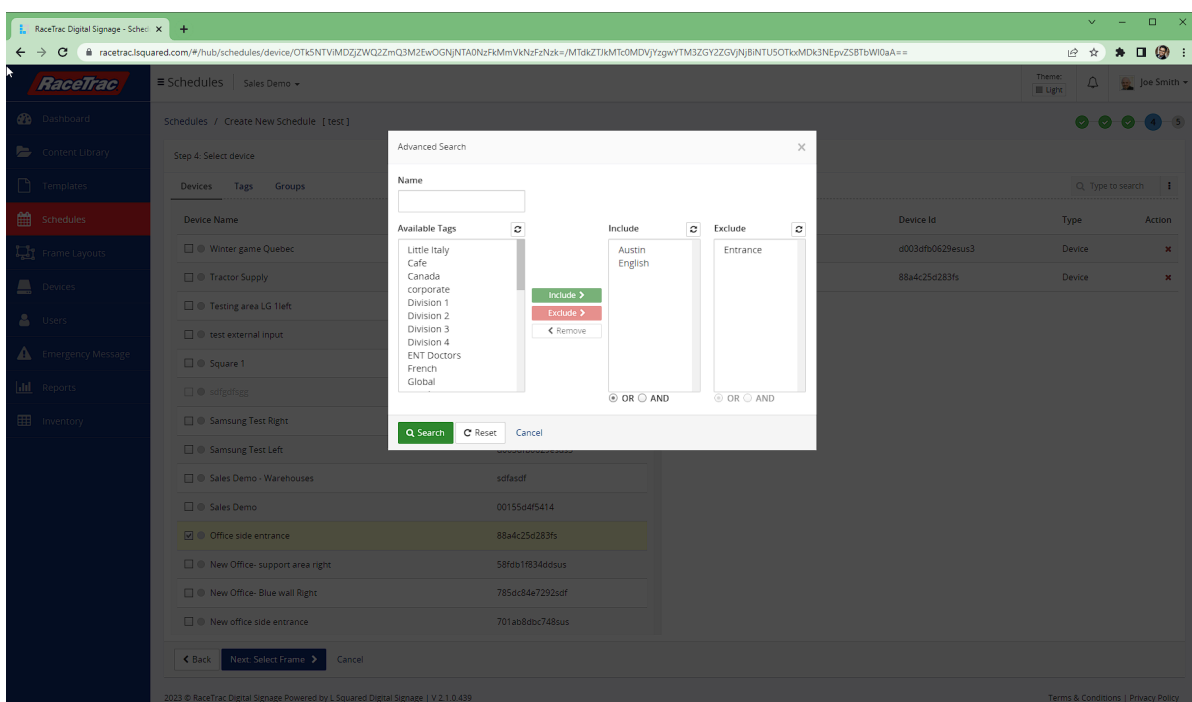

Figure 7: Screenshot of the L Squared Hub advanced search using tags during scheduling process

1.1.8 User Management and Integration with SSO

The L Squared Hub has a built-in user management as well as integration with customer's Single Sign On.

User Management

User's access to the L Squared Hub is governed by two sub systems. One is to control what users can see. The second is to control what actions users can perform. Actions such as upload, add, edit, delete etc.

What users can see is controlled using user groups. An administrator can simply create a user group, assign users to that group and assign that group to different resources in the L Squared Hub such as screens folders, files, content, widget etc. This will result in only users that are part of the group to see and access those content.

Using this mechanism, the digital signage network can be segmented to allow access at national level to some users, regional for some, and just one screen for others.

What users can do is controlled by roles and rights. There are some common roles that are already created such as content manager, content scheduler, etc. It is also very easy to create a custom role and select exactly what actions can be performed by users possessing the role. This will allow administrators to upload content, but not delete for example, or allow upload content but the content they upload requires approval before it can be published to the display.
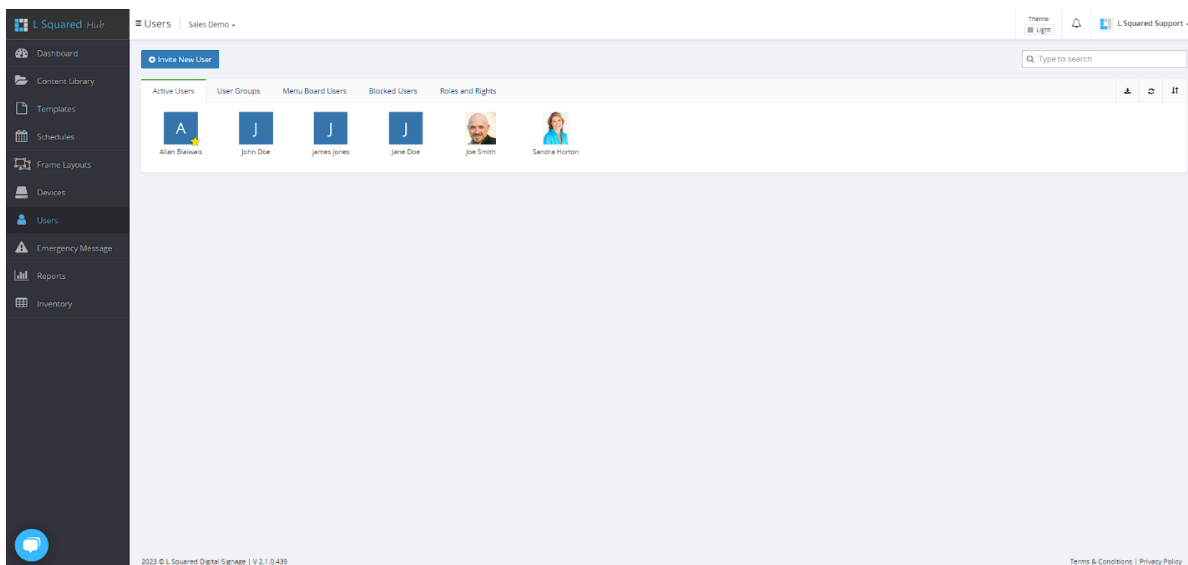

Figure 8: Screenshot of the L Squared Hub's user management screen

Workflow Management

The L Squared Hub can be used to create a workflow for uploading and scheduling content. For example, certain user groups can be given access to upload and edit content and create schedules where their work needs to be approved before it will be promoted to the displays.
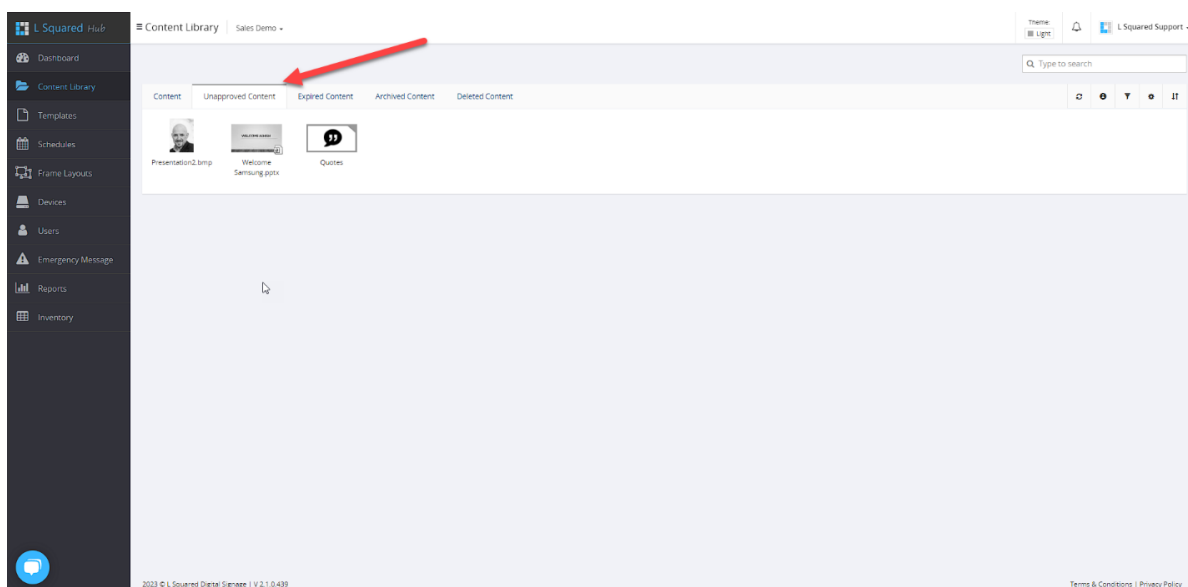

Figure 9: Screenshot showing the unapproved content in the content library. The arrow is showing the tab user clicks on to see the unapproved content.

1.1.9 Graphical Template Creation

Creating templates in the L Squared Hub is extremely easy. There is a powerful graphical design tool that will allow the user to draw and define the templates. Unlimited number of frames can be created on a screen and they can be layered to create powerful effects like drop shadow, transparency etc.

Each frame in a frame layout template will allow users to target unique content to them. For example, as user can display the logo in the top right frame, and a power point slide in the large frame in the middle of the screen using the layout shown below.
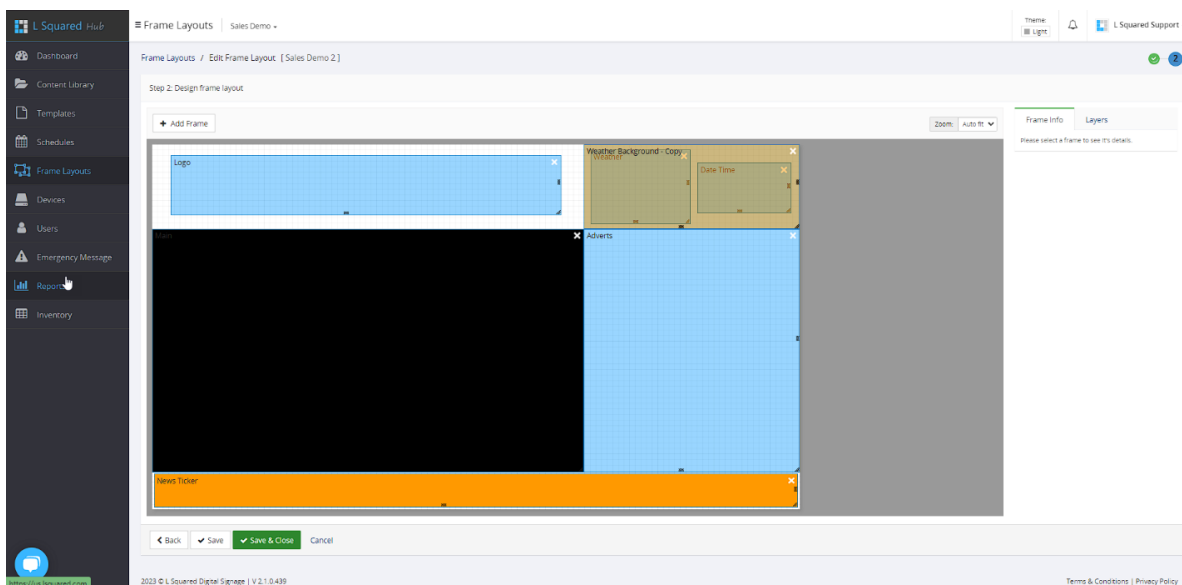

Figure 10: Screenshot showing the frame layout designer.

The above template is used to create the example screen displayed below.

Figure 11: Screenshot showing a sample screen layout with content populated using the template designed in the picture above.

1.1.10 Branded and Themed

The entire application can be customized and branded to the customer's needs. This includes the color, look and feel as well as the logos. The images below shows a customized theme.
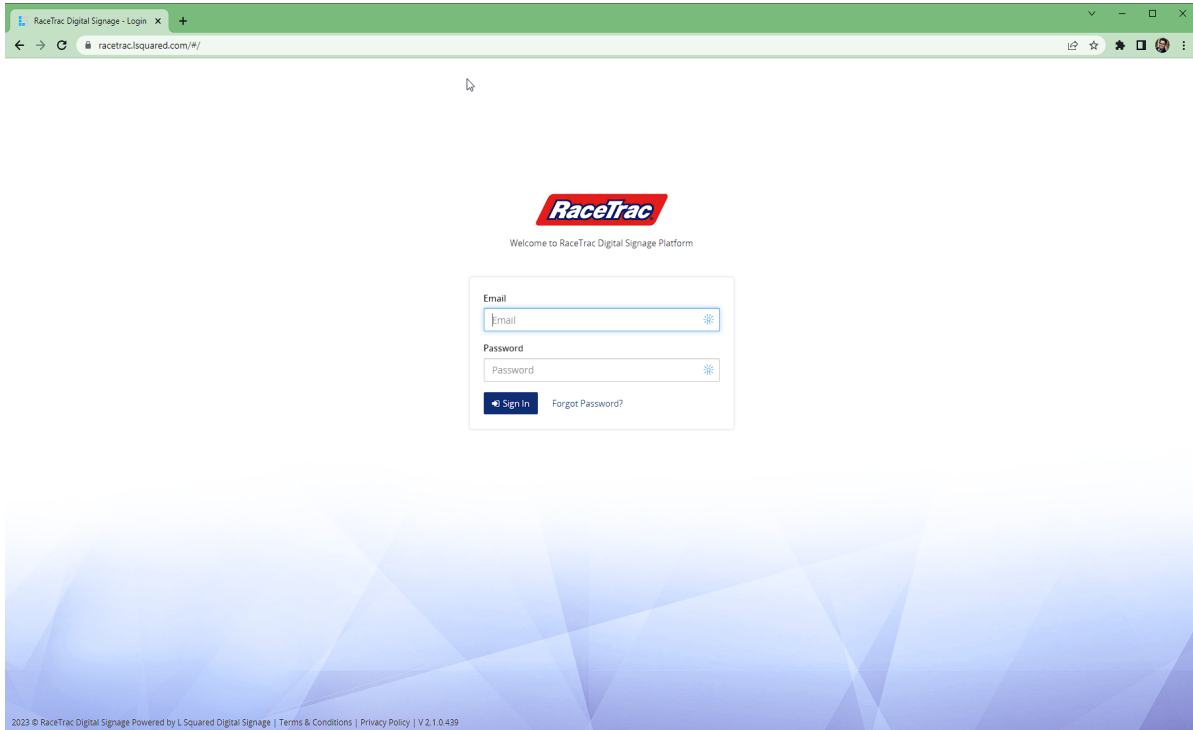

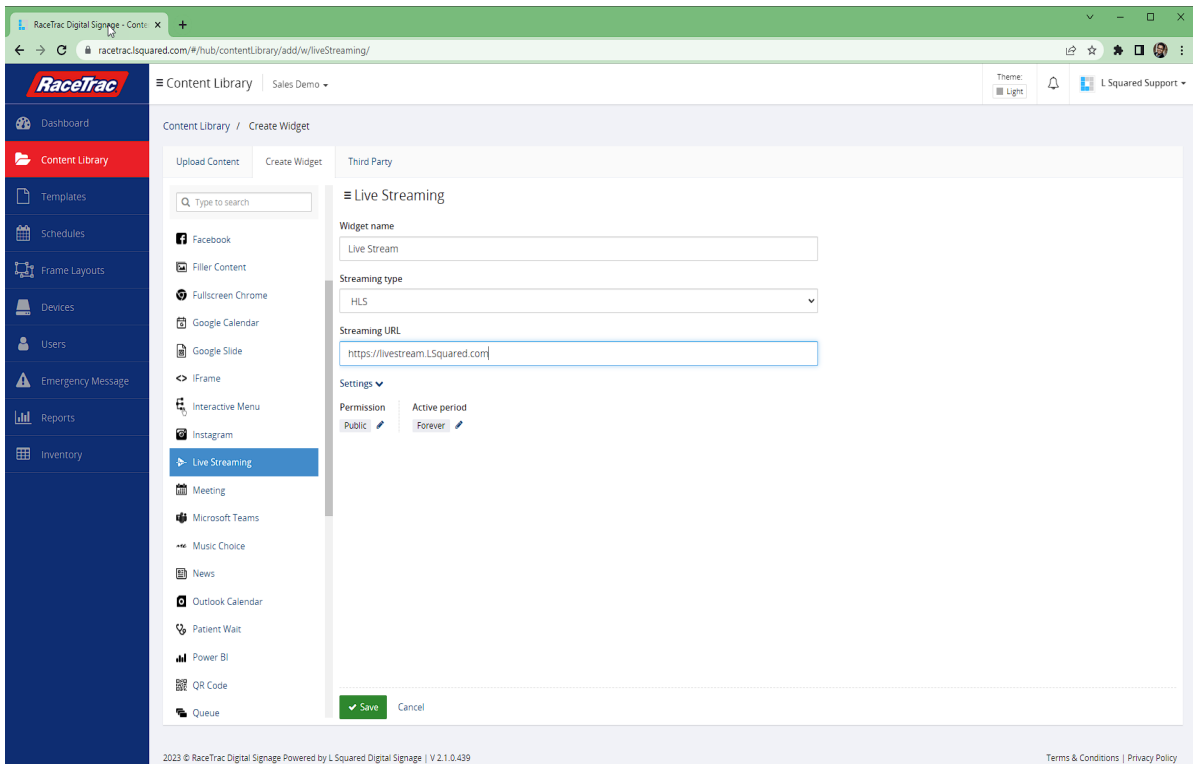*Figure 12: Image of a customized login screen*

Figure 13: Screenshot showing example of a customized theme

The dashboard can be customized by individual user, or an administrator can create a unified look for entire team and apply to all users.

In addition to the web control panel, the user can create templates for the screens that are customized as well. The image below shows sample customization for L Squared. The system allows for custom fonts, different background colors, background images, position of common items like date/time/weather/ticker etc.

Figure 14: Sample screen using customized elements for L Squared

1.1.11 Content on Demand

The content on demand function allow the user to create a solution similar to Netflix for their own organization that can be setup using the L Squared Hub control panel. Once setup, the users of the displays can interrupt digital signage and launch content on demand using the remote control.

This feature allows our customers to utilize the Digital Signage for other purposes such as training, viewing cable TV, business intelligence dashboards, and product demonstrations.

Content on demand can be triggered using remote control or touch screen.
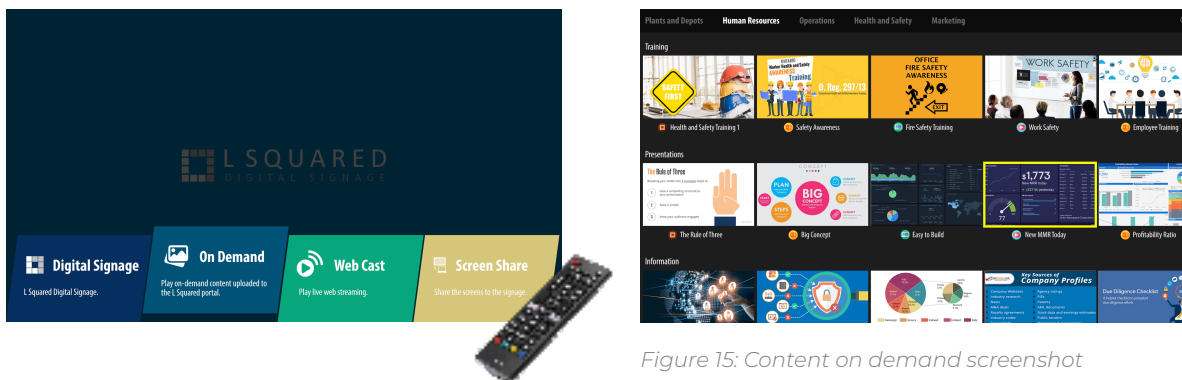

Figure 15: Content on demand screenshot

1.1.12 Live Streaming

The L Squared Hub has native support for live streaming. This allows our customers to display live events including Zoom meetings and Microsoft Teams live events across their entire organization at the same time.
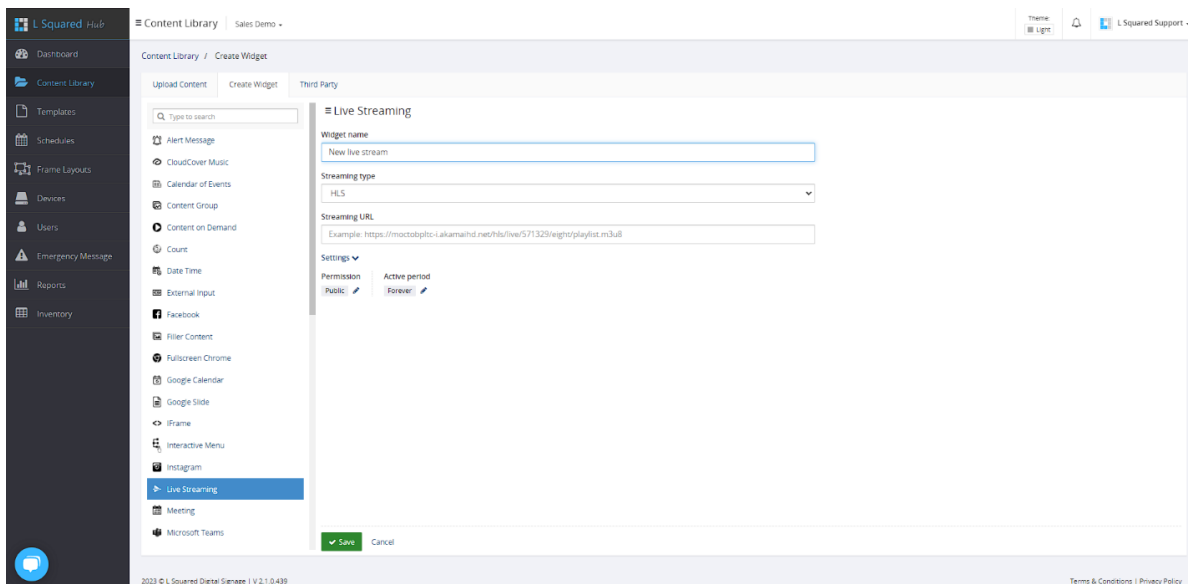

Figure 16: Screenshot of live stream widget creation

1.1.13 Multilingual (English, Spanish and French)

The L Squared Hub is localized into different languages so that users can convert the applications user interface to the language of their choice. Currently we support English, Spanish and French. Other languages are being added in the near future.

This feature is not to be confused with multiple language support for content which is also available. All languages may be used in the content library for display on the screen.
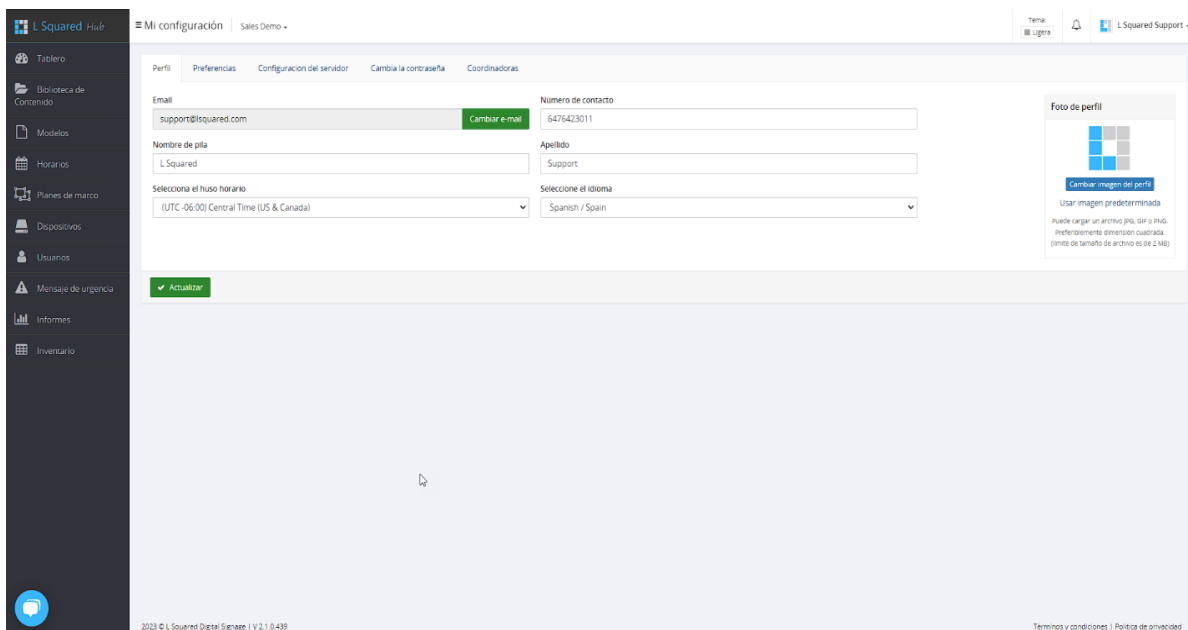

Figure 17: Screenshot of the user settings shown when Spanish language is selected

1.1.14 Integration with Microsoft Power Point and Word

The L Squared Hub provides a plugin for Microsoft Power Point and Word that allow users to publish content from Power Point slide to the displays without having to learn to use the CMS. Microsoft Power Point itself can be used to publish directly to the screen.
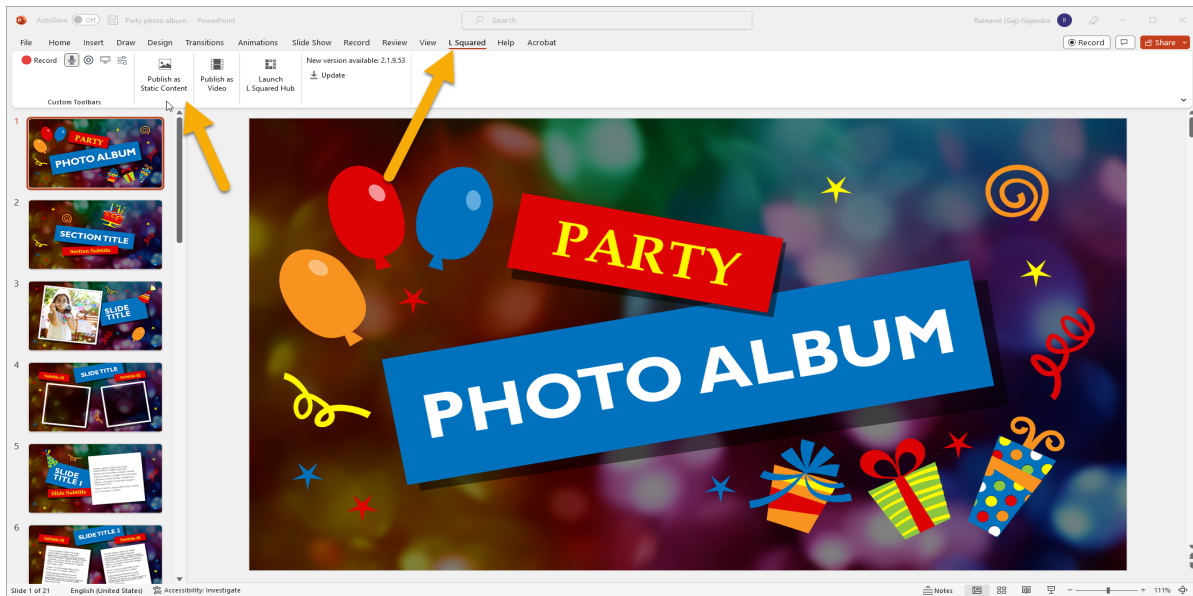

Figure 18: Screenshot of Microsoft Power Point showing the plugin to publish directly from Power Point

1.2 Relevant Widgets

The L Squared Hub adds additional functionality through what we call "Widgets". Widgets are applications that we, and our partners have built to bring new features and functions to solve problems specific to certain organizations. There are a wide variety of widgets already available for customers to use. In addition, we can build new widgets to add functionality to meet customer requirements quickly and with highest of quality due to the widget architecture of the platform.

Of the many widgets available, we selected a few that we feel is relevant.

Figure 19: Image of a sample display showing date time, weather, twitter and scrolling text widgets

1.2.1 Date and Time

The date and time can be set specifically for each display based on the address. The widget can be scheduled in any frame allowing for many different designs.

1.2.2 Weather

Live current weather and forecast is available to be displayed on the screen.

1.2.3 Hours of Operation

This widget allows stores to create their own hours of operation and schedule it specific to their display.

1.2.4 Websites

This widget allows customers to display websites on the screen.

1.2.5 Power BI

Power BI Widget allow users to display live Power BI dashboards and reports. Power BI is a Microsoft data visualization and business intelligence.

Figure 20: Screenshot showing live dashboard from Power BI in the main frame of this screen

1.2.6 QR Code

The L Squared Hub allows users to generate QR code that can link to a URL, to content in the content library of the L Squared Hub or L Squared Hub device. This allows users with mobile devices to interact with the Digital Signage using QR codes. The L Squared Hub, using QR Codes, can facilitate customer surveys, coupons, wayfinding and much more.
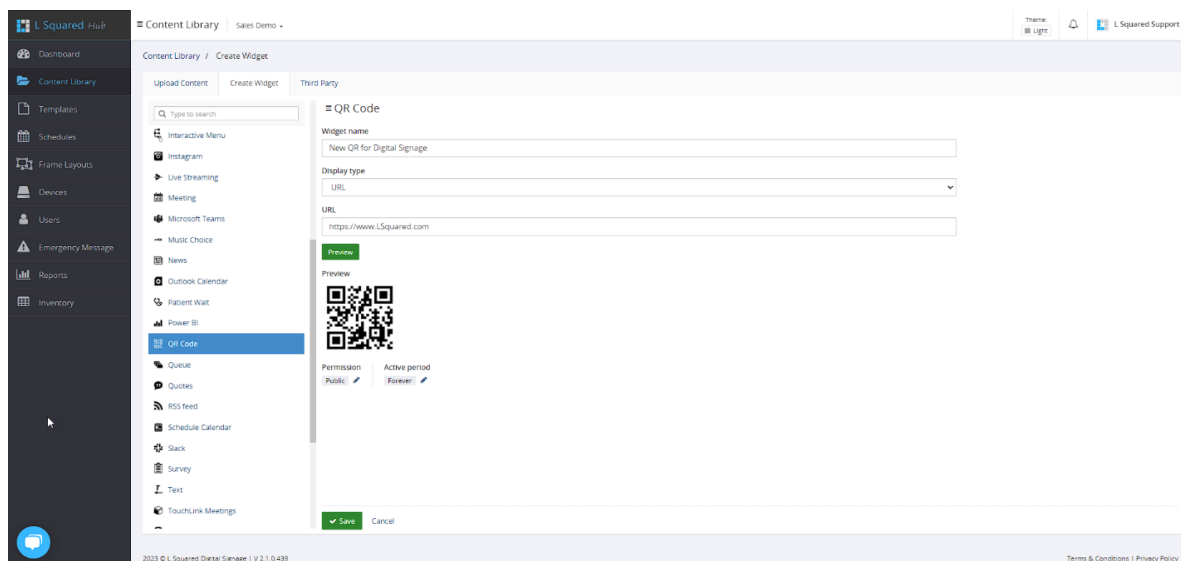
Figure 21: Image showing the creation of a QR code widget

1.2.7 RSS Feed

Custom RSS can be used to display dynamic content from third party solutions on the display. This can be anything from emergency messages to news.

1.2.8 Social Media

The L Squared Hub integrates with social media and employee recognition system like Twitter and Social Chorus.

1.2.9 YouTube and Vimeo

L Squared Hub widget for YouTube and Vimeo allow users to publish content from these video sharing platforms to the displays. This includes live events.

1.2.10 Calendar of Events

The calendar of events widget allows users to publish event schedules to the screens.

1.3 Dynamic Editable Menu Board Portal

The L Squared Hub has a unique function designed for menu boards. Menu board templates can be created with dynamic editable items and integration with point-of-sale system is possible. This allows for users that are concerned with just menu board to quickly access and edit menu board content. The menu board function is unique to our application that creates a robust solution for convenience store menu boards.

Utilizing this menu board portal, a user can quickly access their menu and change specials, or menu pricing quickly without the need for training on the entire CMS solution.
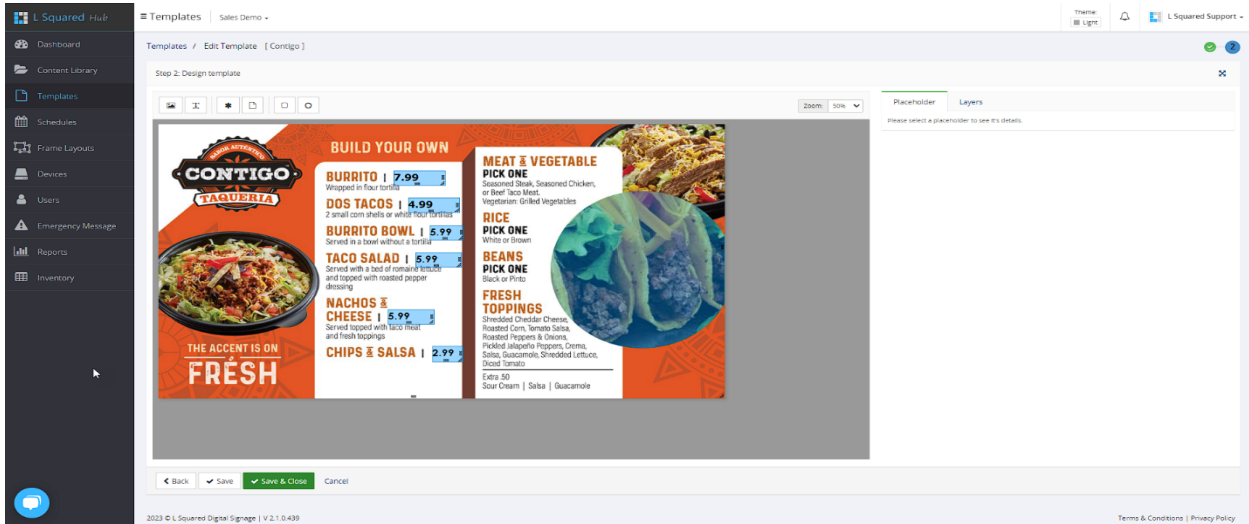
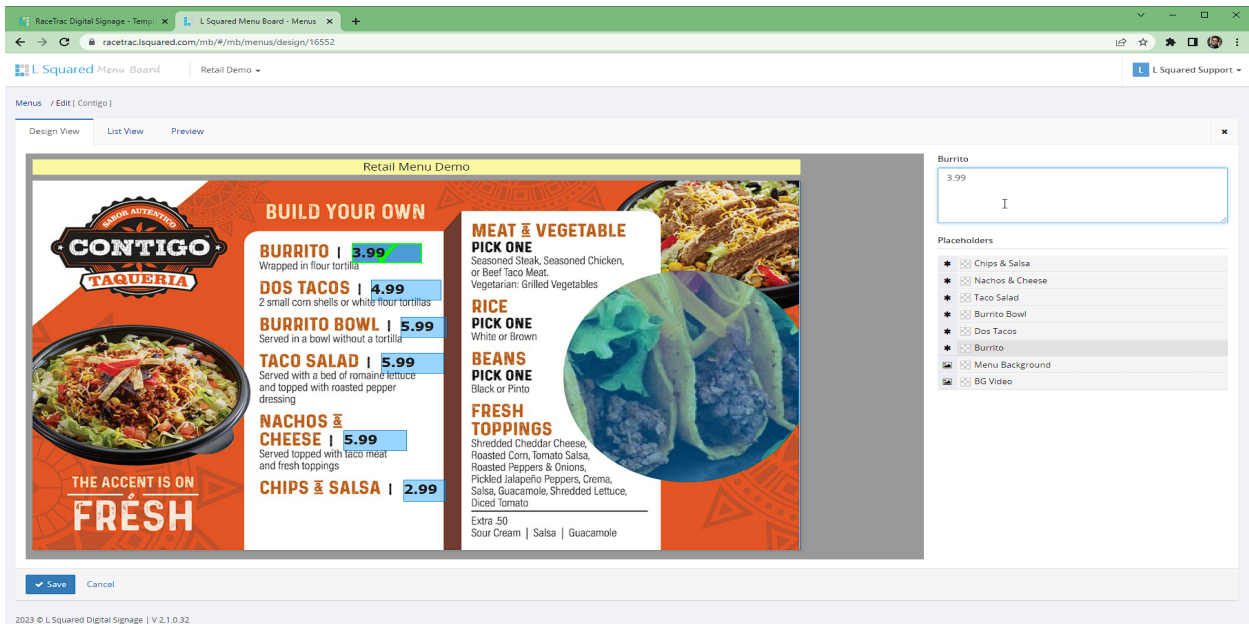*Figure 22: Screenshot showing the menu template editor*

Figure 23: Screenshot showing the menu board portal

1.4 Hardware Support and System On Chip

The L Squared Hub is hardware agnostic. It is built on technology that can work on many different types of hardware and operating systems. This includes LG WebOS, Samsung Tizen, Sony/Philips Android, Android Media Players, and Microsoft Windows Media Players. We work closely with Samsung and LGs engineering groups to deliver powerful, integrated solutions that allow for much better control of the displays.

1.5 Display Control

The L Squared Hub allows users to control many settings on the displays over the Internet. Settings such as the on/off timers to set when the displays turn on and off. This functionality exists on both System on Chip displays and on commercial displays using media players that support the RS232 control mechanism.

In addition, we utilize functions available on certain system on chip displays to get serial numbers, total time the display has been on for, temperature, hardware disk used, etc to manage and report on inventory and determine health of the displays.

1.6 Inventory Management

The L Squared Hub has an inventory management function that allows our customers to gain complete visibility on all inventory in use with the entire digital signage network. The inventory management system is automated for customers that utilize system on chip where the system will get serial number and system on-time from the displays directly and track when they are connected. The system also tracks accessories like remote controls, sensors etc. In addition to inventory management, this function allows users to track and utilize warranty and perform hardware life cycle management.

Lastly, the inventory management keeps a log of the life of the hardware so that users can generate an audit log ensuring the system was properly recycled with any sensitive data removed with proof of disposal.

1.7 Device Management, Software and Firmware Updates

The L Squared Hub has a robust device management system built in that allow administrators to manage all devices irrespective of their make and model in the same way. Once registered into the L Squared Hub, the administrators can see in real-time on a dashboard all aspects of the device including: resolution, name, IP addresses, MAC Address, system log, on/off status, last connected date and time, hard disk, memory and CPU usage, serial number and much more.

The system allows administrators to update the firmware on System On Chip displays over the Internet to ensure they are the latest and secure. Application updates are automated when L Squared Hub is updated, all client systems are automatically updated with little to no interruption to the user. The update usually happens overnight when the screens are not being used. They can also be scheduled at a specific time if required.

All this information can also be downloaded as a report as well.

Figure 24: Screenshot showing the devices section with memory and disk usage information

1.8 Deployment Automation

Deployment of large number of displays are often a complex task. L Squared Hub simplifies this by allowing system integrators and administrators to pre-populate the software with display configurations. This means that any display can be shipped to any location. Once at the end location, the local technician simply connects the screen to the Internet and enters the code specific to that location defined in L Squared Hub software. This will automatically configure the screen and connect it to the L Squared Hub making on the fly deployment very easy.

1.9 Integration with CISCO Meraki

The L Squared Hub integrates with many third-party solutions and hardware. One of those integrations that may be of special fit is the integration with Meraki hardware. If the customer is using a Meraki network equipment, the L Squared Hub can add functionality to increase the return on the investment in Meraki as well as in L Squared.

The CISCO sensors and accessories we currently support:
Air Quality, Humidity, Water Leak, Temperature (including refrigerators), Probe and Button

MT10

Indoor temperature and humidity sensor

- Temperature range: 0°C to 55°C
- Humidity range: 0% to 95% RH

MT11

Indoor temperature probe sensor

- Temperature from -40°C to 55°C
- Multiple probe options available

MT12

Indoor water leak detection sensor

- Multiple leak detection options
- IPX5-rated

MT14

Indoor air quality sensor

- Monitor PM2.5 and TVOC
- Monitor temperature, humidity, and noise

MT20

Indoor open/close sensor

- Five-year battery life
- Physical tamper detection

MT30

Smart automation button
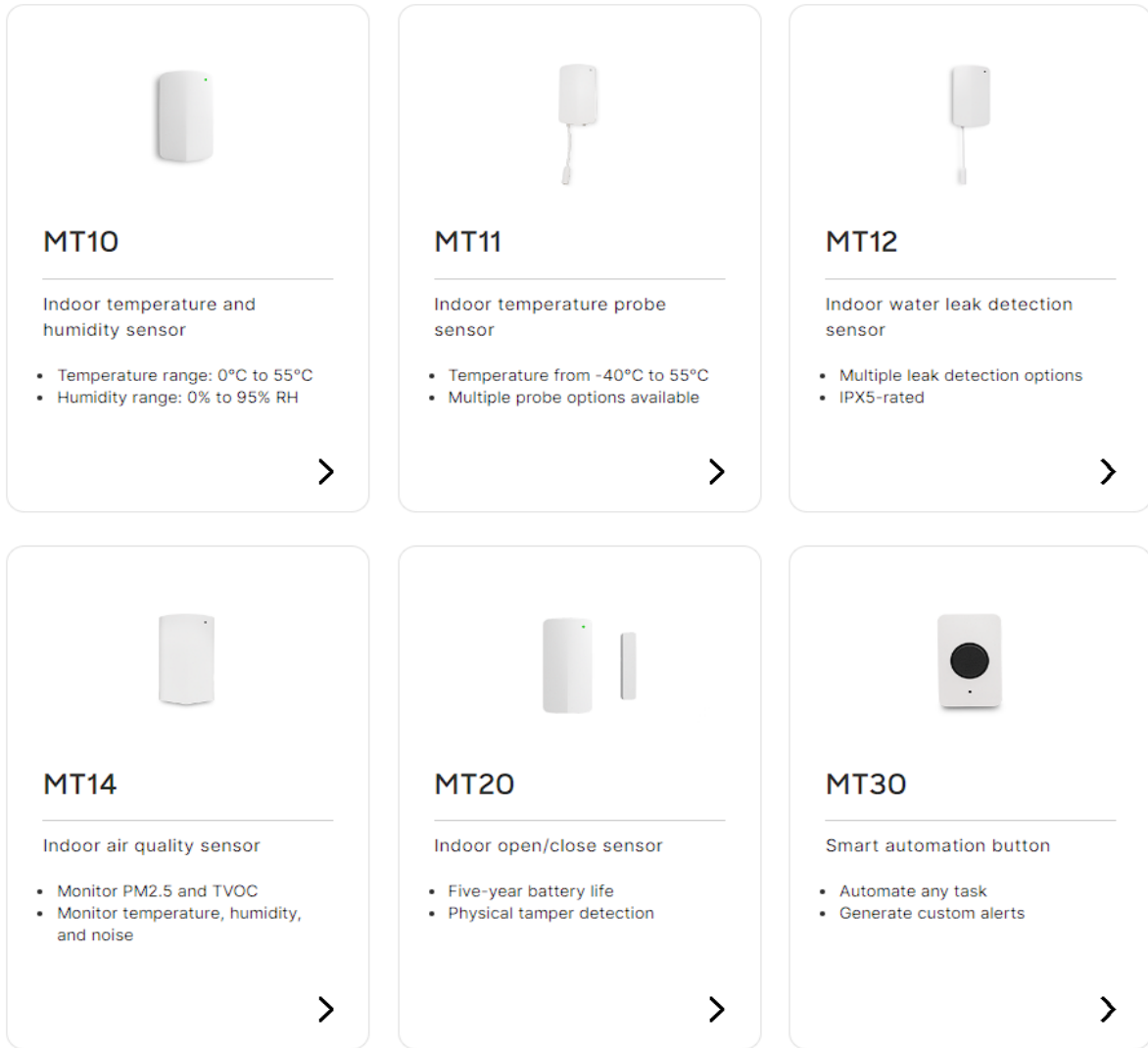
- Automate any task
- Generate custom alerts

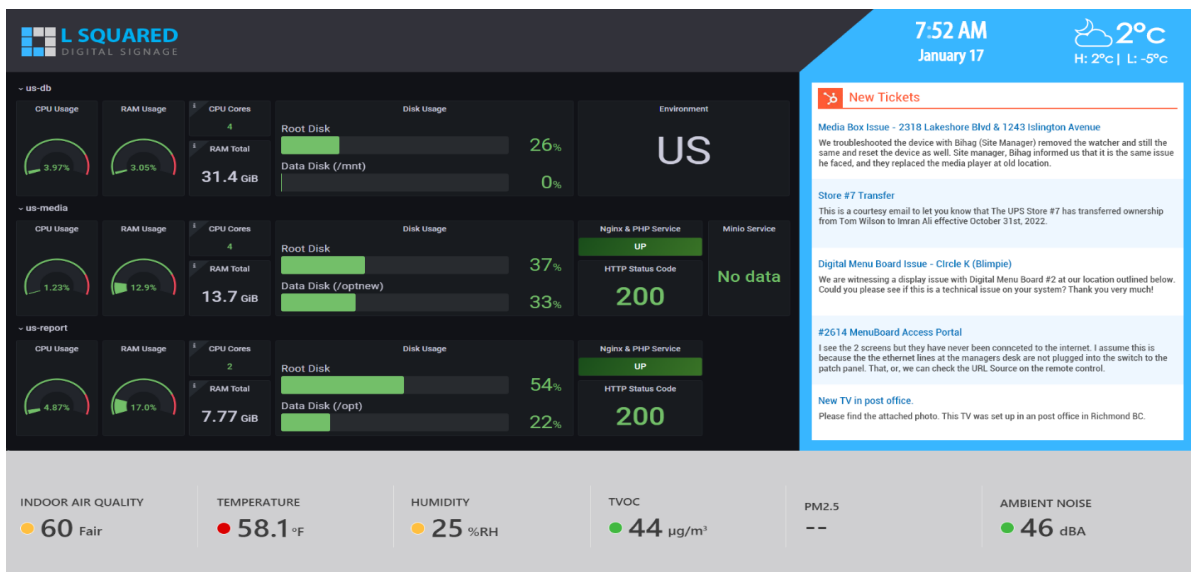*Figure 25: Image showing the different type of sensors for the Meraki network*

Figure 26: Display showing the sensor data displayed on the bottom of the screen.

1.10 Security

The L Squared Hub is an Enterprise Content Management platform that was built to be secure from ground up. The following describes some of the high-level security functions.

Utilizing Microsoft Azure as the infrastructure allows us to create a robust, scalable and secure solution in the cloud. Microsoft provides a world class environment as well as tools to monitor and manage security.

In the Cloud

Azure security monitor: Azure security monitor is used to monitor the network for security threats.

- **End to End Encryption:** All communication to and from the client and server is encrypted with the industry best encryption standards.

- **Two Factor Authentication:** Two factor authentication can be used for all users.

- **Strong Password Policy:** Strong password policy is enforced to ensure that all users are using passwords that are secure.

- **Role Based Access Control:** Each user's access to the system can be controlled by role and user groups.

- **Integration with SSO:** User credentials and access can be controlled through customer's Single Sign On solution.

- **Penetration Testing:** Third party penetration test is performed every year. Report is available for customers to review

Audit Summary					
Engagement Type	Web Application Security Audit				
Methodology	Blackbox Security Audit				
Date of Audit	30th August 2022				
Engagement Details	Appknox was contracted by L Squared Digital Signage to conduct a penetration testing to test its defences and exposure to an attack. Activities were simulated in a manner a malicious actor would breach the company's assets and private data. Assessment conducted is conforming with NIST SP 800-115 with all relevant tests conducted in a controlled environment.				
Researcher	Ajay <ajay@appknox.com>				
Scope Included	https://us.lsquared.com/				
Environment	Production				
Roles Tested	User				
Exclusions	Forget Password				
Assessment Summary	Critical	High	Medium	Low	Passed	Total
	0	0	0	0	120	120
Security Score	**10**/ 10	**0.0 - 6.0**: Highly Vulnerable **6.1 - 8.0**: Vulnerable **8.1 - 9.9**: Be Preventive **10**: Secure				

Figure 27: Summary of the report from our last test

- **Vulnerability Scanning:** Our web application is scanned weekly for known vulnerabilities by a third party automated vulnerability scanning tool.
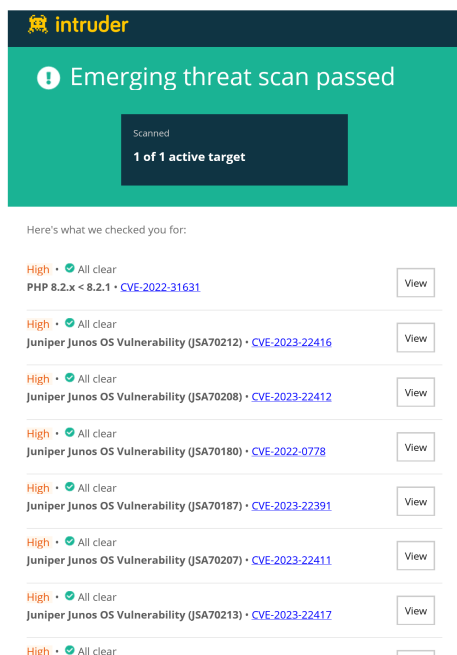

Figure 28: Results of last vulnerability scan

On the Devices

Azure security monitor: Azure security monitor is used to monitor the network for security We take an all-encompassing approach to security. This means that all aspects of the solution require strong protection including end points such as media players and system on chip screens. The L Squared Hub solution secures end points using features and functions of the respective hardware and operating systems.

- **Shell Launcher:** Shell launcher ensures that only the application approved to run are running.
- **Software Watchdog:** This ensures that the application approved to run is running consistently. If anything causes the application to stop running, the watchdog will shut down the process and restart it again automatically acting as a self-healing system.
- **Keyboard Filters:** Keyboard filters protect against unwanted access. For example, on our Windows media players, users will not be able to connect a USB keyboard and attempt to gain access to the media player because the keyboard filters ensures that the keyboard does not work until an administrator's password is entered.
- **Operating System Hardening:** The L Squared Hub utilizes the functions available on the operating system to harden the operating system. For example on LG WebOS, we deploy a secure profile to block unnecessary ports from communicating on the network, enable the software watchdog, disable access to remote control, lock out the Wi-Fi and onscreen controls etc. Similar hardening profiles are available for Samsung Tizen, and Microsoft Windows operating systems.

1.10.1 SOC 2 Compliance

L Squared uses third-party automation to monitor, track and report continuously on compliance with SOC 2 controls. We are 100% compliance and a third party independent audit is underway right now with expected audit report in April.
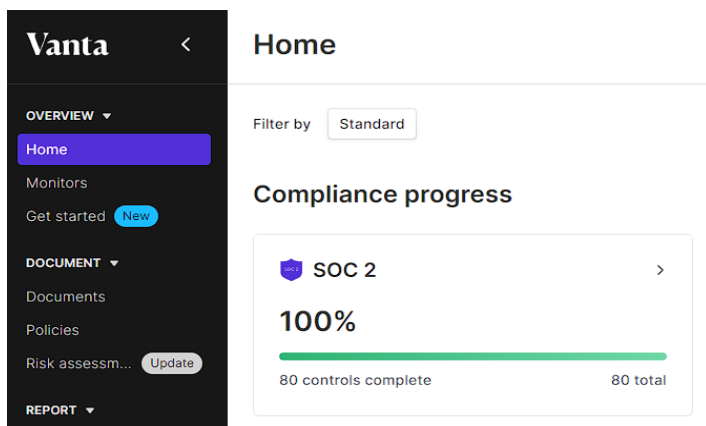

Figure 29: Screenshot of the SOC automation software showing 100% compliance.

1.11 Performance and Scalability

We utilize industries latest technologies and constantly update and upgrade our infrastructure as well as the underlying technology used to develop the application. In addition, the use of industry's premiere cloud infrastructure (Microsoft Azure) allows us to deliver exceptional performance even when there are tens of thousands of screens connected to a single server.

The L Squared Hub is optimized for LG WebOS, Samsung Tizen and Microsoft Windows client devices.

L Squared Hub's administration console is accessed through the Internet on a web browser. Any computer can be used, including mobile devices. The interface is designed to be easy to use, and performs like a desktop application.

The server infrastructure in the cloud can be scaled from 1 screen to over 100,000 screens with a few clicks of the mouse without any downtime.

1.12 Future – Augmented/Virtual Reality, Shelf Labels, Sensors, EV Charging

The L Squared Hub is a complete communication platform. It allows our customer to put the right messaging in front of the right people at the right time and place allowing those people to make better decisions. This means we are looking at ways to improve how we enable our customers to deliver their message.

L Squared Hub already supports mobile devices, wide variety of displays, desktop computers, websites, ePaper Display, Shelf Labels, EV Charging Stations and more.

We are working on solutions using augmented reality, virtual reality (metaverse) and wearables.

We evolve our solution with the input of our existing customers. There is a feature in the L Squared Hub that allows users to request new features and functions that we develop for our customers on a quarterly basis.
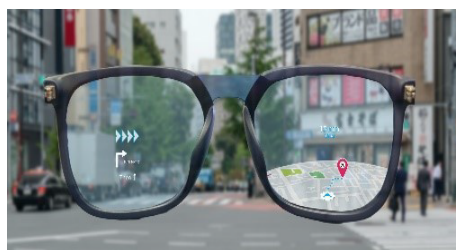
1.13 Customization and Future Integrations

We are continuously adding new features to the L Squared Hub with the input of our customers. In addition to the features we add as part of our roadmap, the widget architecture and flexible development process allow us to customize our digital signage solution to meet our customer's requirements. As the needs of our customer changes, we can change with them to meet their goals. Fundamentally, we are obsessed with our customer's success.

2 In-Store / Background Music

The L Squared Hub can work with any In-Store music platform and integrate with them for a seamless experience. We have deployed combined solution for other retail customers like The UPS Store nationally in partnership with Cloud Cover Music.

3 Deployment

L Squared is uniquely positioned to provide the best deployment experience for both existing and new locations.

We work closely with local and national sub-contractors like Best Buy for Business. Utilizing partner resources such as Geek Squad city to first kit all necessary hardware according to bill of materials for new locations. All equipment is tested, prepared, staged and packaged into a kit for deployment. The equipment is shipped to the site as a kit with the technicians scheduled to install after the kit arrives on site.

We provide the a complete managed, turn-key deployment anywhere in the country combined with the best pricing on hardware.

3.1 Procurement of Hardware, Staging and Kitting

L Squared will procure all hardware necessary for our customers. Hardware can be allocated based on projected requirements of new site openings. Hardware is stored, kit and tested at our partner facilities before shipping to the required sites. We work with manufacturers, distributors and sub-contractors to coordinate a seamless experience for our customers.

4 Post Deployment Support

4.1 Software Update and Maintenance

All software and firmware is managed by L Squared for complete trouble free operation. L Squared's support team utilizes the functions of the L Squared Hub to update the firmware of SoC displays, the operating system of media players and the L Squared client application automatically over the Internet with little to no interruption to the user. This is usually scheduled for overnight so the user is unaware of the updates.
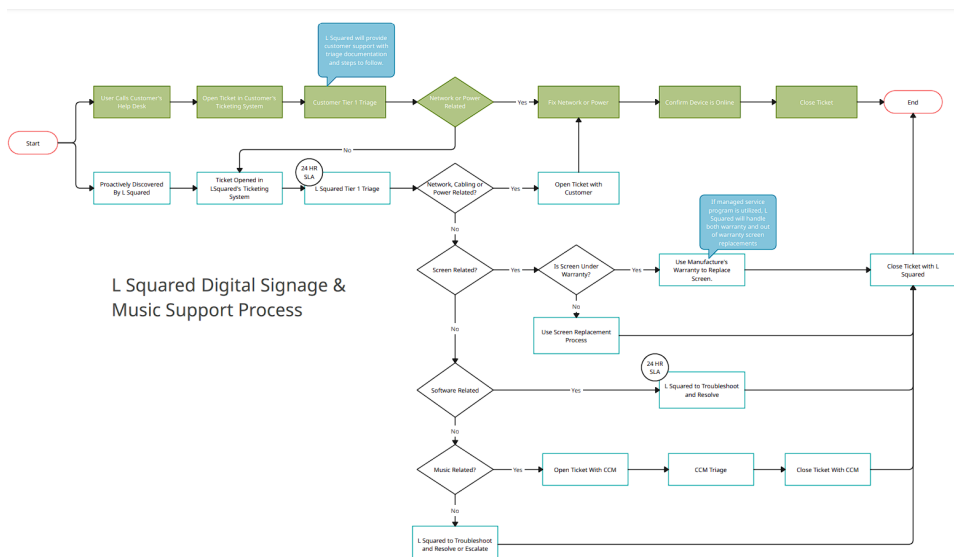
Our update process is carefully planned and always have a way to roll back any updates we make. At a minimum we update the software once per quarter with minor fixes and features. Once a year there is a larger feature update. All updates go through internal testing, a beta test phase then a gradual rollout schedule to customers.

4.2 Backup and Recovery

All customer data, application and cloud infrastructure is backed up daily. We have redundant cloud systems on standby as well to quickly recover in the case of any failures of the infrastructure. At most there may be 1 day worth of data loss in the case of a disaster.
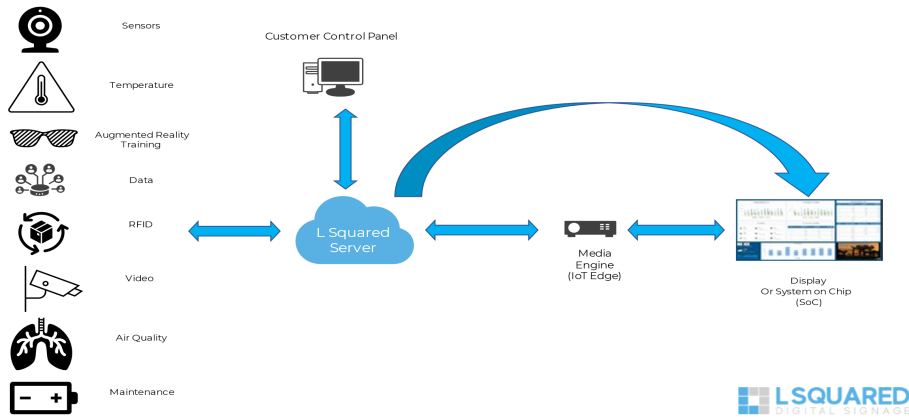
Our infrastructure and support tools are all in the cloud and all have redundancy built into handle disaster scenarios like pandemics easily. Our entire work force can work with 100% productivity remotely.

4.3 Sample Support Workflow

L Squared Digital Signage & Music Support Process

Cloud

Sensors
Temperature
Augmented Reality Training
Data
RFID
Video
Air Quality
Maintenance

Customer Control Panel

L Squared Server

Media Engine (IoT Edge)

Display Or System on Chip (SoC)

4.4 Network Architecture

Digital Signage Admin Terminal
IP (Customer IP Range)

L Squared Hub

Web/API Server
(Linux Server)

Content Storage
and Delivery Server
(Linux Server)

Database
(Linux Server)

Outgoing TCP Port 443

IP: D.C.B.A
Incoming: 443
Outgoing: Unrestricted

Internet Cloud

**Third Party Servers in
Unknown Location
(Optional)**

Google DNS
IP 8.8.8.8
IP 8.8.4.4

IP: A.B.C.D
Incoming: All Blocked
Outgoing: Ports 443, 53

Customer's
Modem/Switch

**Open Outgoing Ports that
need to be opened on
customer Firewall**

443: Internet, general support
and remote connection

53: DNS

LAN

WiFi or Ethernet

Screens

Screens