



Whitepaper

Visualize Your Networks with Next-Generation Serverless EnGenius Cloud

This article demonstrates how EnGenius Cloud achieves reliable and scalable cloud infrastructure and the unique features it offers to help IT managers better visualize their networks with important insights.

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Introduction

The cloud-managed network model has gained widespread acceptance in the enterprise world. According to a report by the IDC, cloud-based deployments made up 26% of all deployments in the year 2017, a number expected to grow to 38% by 2020. Much of this growth stems from a demand for greater network scalability and agility, especially for distributed branches under a centralized IT infrastructure. This is a common paradigm for small-to-medium businesses in the era of globalization.

On-Premises vs. Cloud

EnGenius has provided on-premises ezMaster Network Management solutions for many years to centrally manage EnGenius Switch and Access Points locally or from remote site. EnGenius customers can install ezMaster on their on-prem server or on AWS, and now an integrated SkyKey appliances is available for users to simply plug the ezMaster-embedded SkyKey to one of switch port in the network. In recent years, EnGenius invested more in the latest cloud-computing technology and serverless infrastructure to provide our customers the most advanced plug-and-play, easy-to-use EnGenius Cloud solution. Thus IT managers simply need to focus on how they want to manage their networks, without worrying about server capacity, performance and scalability.

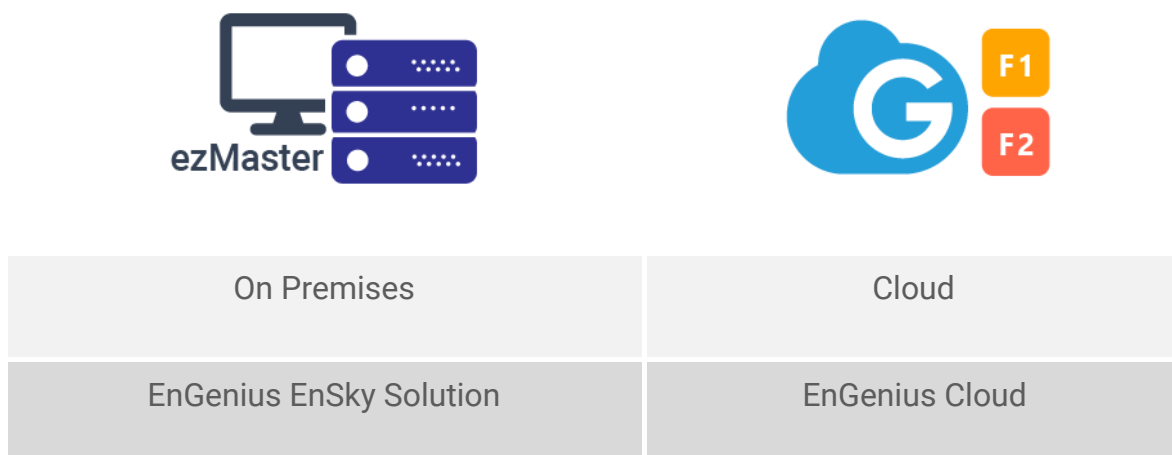
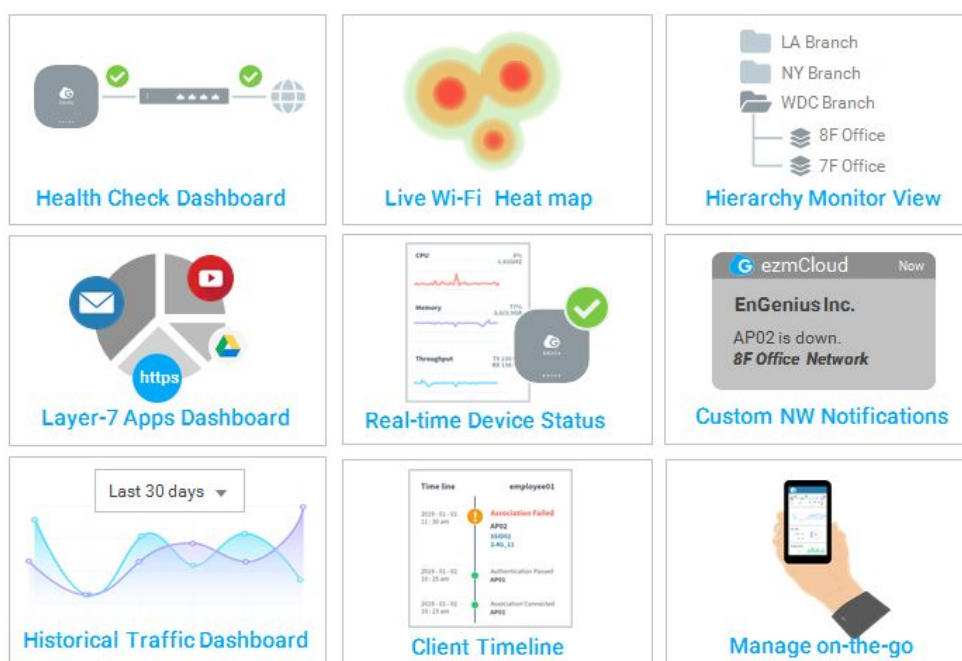


figure 1 - EnGenius On-Premise and Cloud Solution

Network Visualization

In accordance with the EnGenius corporate philosophy of ease-of-use and in-sight visualization, the company seeks to reduce customer pain points in networking with tools for easier planning, deployment, and management. EnGenius Cloud integrates in-house Wi-Fi Planner technology into the cloud, offering users the ability to visualize Wi-Fi coverage with Cloud-managed APs. EnGenius Cloud has also built an AI-ready platform with Big Data infrastructure and cloud computing technology to centralize logs of whole networks and do analysis.



Serverless Cloud Infrastructure for High Resilience and Scalability

Docker-Based First-Generation Cloud

EnGenius' involvement in cloud technology development began many years ago when customers started to demand cloud services with zero-deployment options. In response, EnGenius built a first-generation cloud to deploy a customized instance of ezMaster manager onto cloud-based Docker containers, and built a Docker manager to facilitate resource allocation. The server or Docker-based cloud approach is now a common practice for many cloud solution vendors. However, we discovered a number of issues after performing a variety of stress tests.

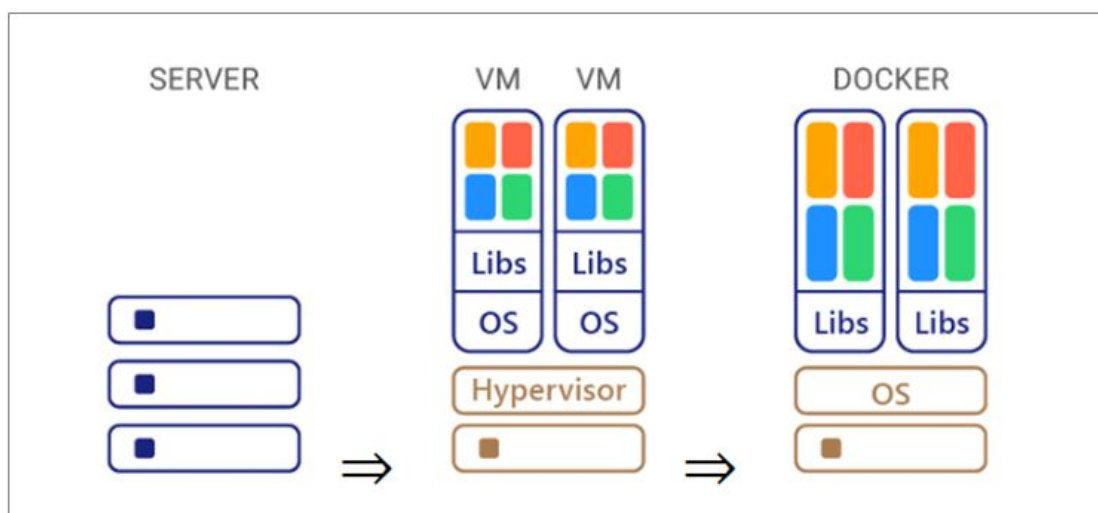


Figure 2 - Server vs. Virtual Machine vs. Docker

Note:

Server-Based Cloud - physical machines placed in cloud datacenters with specific CPU, memory etc. Similar to traditional IaaS services.

Virtual Machine-Based Cloud - There is no physical machine limit, but the VM still requires specific CPU and memory space to install OS and bins/libs to run the application. VM leverages hypervisors to manage physical servers underneath.

Docker-Based Cloud - Docker runs on the same OS for smaller services to gain the benefit of sharing OS resources, but each container contains its own binaries and directories. Usually a Docker container manager is used to manage scaling and the container lifecycle.

Not Really a True Cloud

In our daily experience, cloud services should be able to handle needs both large and small, anytime, anywhere. Likewise, the Cloud Network Manager should be able to handle hundreds of thousands of devices in a scalable way, and provide always-on service with a design built for resiliency and disaster recovery.

In the Docker-based first-generation cloud infrastructure, we found the following common issues:

- Inadequate data protection
- Not scalable (requires manual adjustment)
- Cannot plug-and-play and requires port setting on firewall
- Limitation on the number of managed nodes per site
- Poor performance when capacity limit is reached

Customers would be initially unaware of these issues as the cloud operation team could manage problems by closely monitoring the capacity of Docker containers and fine-tuning size, or rebuild the container if necessary. In the long run, however, this might result in downtime caused by machine performance issues or human error. EnGenius decided to migrate to a next-generation cloud architecture design to ensure a more sustainable level of quality for EnGenius services.

Next-Generation Serverless FaaS Cloud

Serverless infrastructures abstract the server components and adjust for scale based on event-driven function requirements. Whenever there is a new function request, appropriate resources will be allocated based on the function characteristics. Serverless design not only increases the resource utilization rate, but also increase performance for each function, Serverless design is therefore referred to as FaaS (Function-as-a-Service) design.

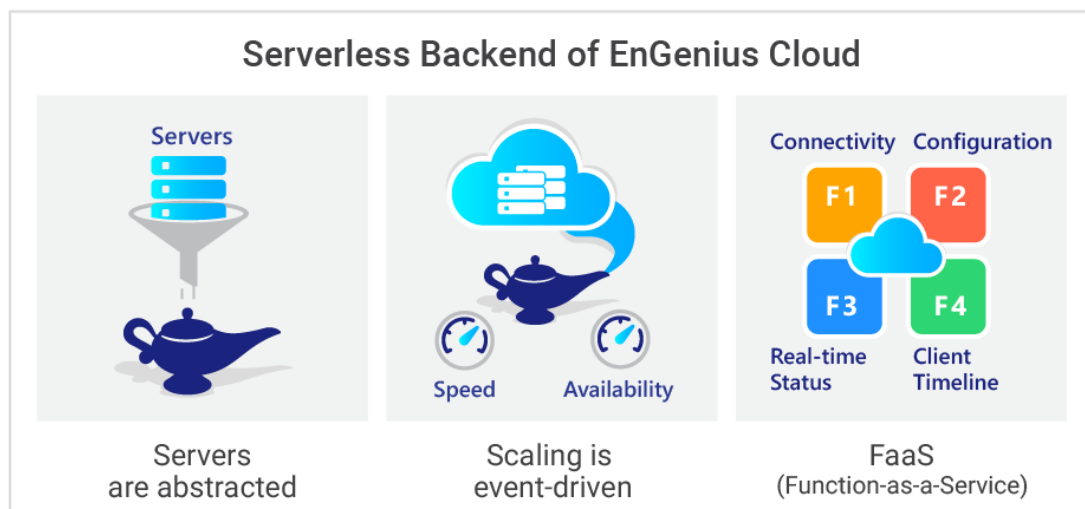
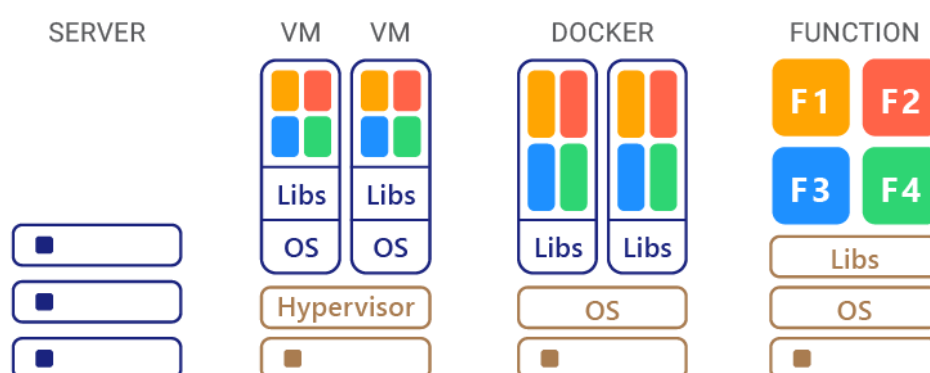


Figure 3- *Serverless Cloud*

There are many different functions in network management, including hardware device connectivity, configuration, historical dashboard, real-time device utilization status, and notification. Each function has unique requirements in its backend design for high efficiency. Serverless FaaS architecture dispatches different function requests to different backend service pipelines under a event-triggered base. FaaS doesn't need to consider server/VM/Docker limitations, so the infrastructure is flexible and scalable to adapt to sudden demand spikes that would overwhelm previous architectures. Most importantly, serverless design allows EnGenius Cloud to streamline the redundancy of components in cloud infrastructure and perform database backup and restoration where the customer's network information is located.

The following table (figure 4) states the difference between server-based, VM, Docker container, and FaaS approaches. For on-premises server, the scale limitation relies on the machine's CPU, memory and size of database. When

scaling up, IT must purchase additional servers and copy all relevant files to the new server, which may take days or months. For VM or Docker, scalability relies on the limitation of physical machines in the datacenter, although users can select whatever size they need on demand. It is also constrained by the size of the database, and the limitation of applications. When moving to a different-scale environment is required, it will take from minutes to days to complete, depending on the flexibility of container management deployment. For FaaS serverless design, all servers are abstracted and scaling takes mere seconds, increasing ease of scalability, as well as quick reduction of resources when demand for resources is lower.



	Server	VM	Docker	FaaS
Scale Boundary	On Premises Machine	Machine	Machine & Application Libs	Function (Micro-Service)
Run Time	Days–Months	Hours–Months	Minutes–Days	Micro-Sec-Sec onds
Cost	New Server	Per VM	Per VM	Per Request
Solution	On-Prem ezMaster	On-Prem ezMaster on AWS	1st Generation Cloud	Next Generation Cloud

Figure 4- Compare between different cloud architecture approaches

AI-Ready “Visualized” Infrastructure

When the scale is greater, the complexity of data storage and analytics also increases. EnGenius Cloud leverages big-data storage and analytics technology to do client timestamp analysis, customizable dashboard and notifications. EnGenius Cloud is designed to easily add modules and perform AI analysis, machine learning, and correlative advisory for troubleshooting.

Passing Cost-Savings on to Customers

The other key benefit of Serverless FaaS architecture is cost savings. Research conducted by Libhiv and Heavywater supports the conclusion that moving applications from server-based to serverless architecture can achieve cost savings of up to 90%. EnGenius Cloud has built in-house serverless FaaS infrastructure to provide more efficient cloud infrastructure and return the cost savings in the form of affordable solutions for SMB customers.

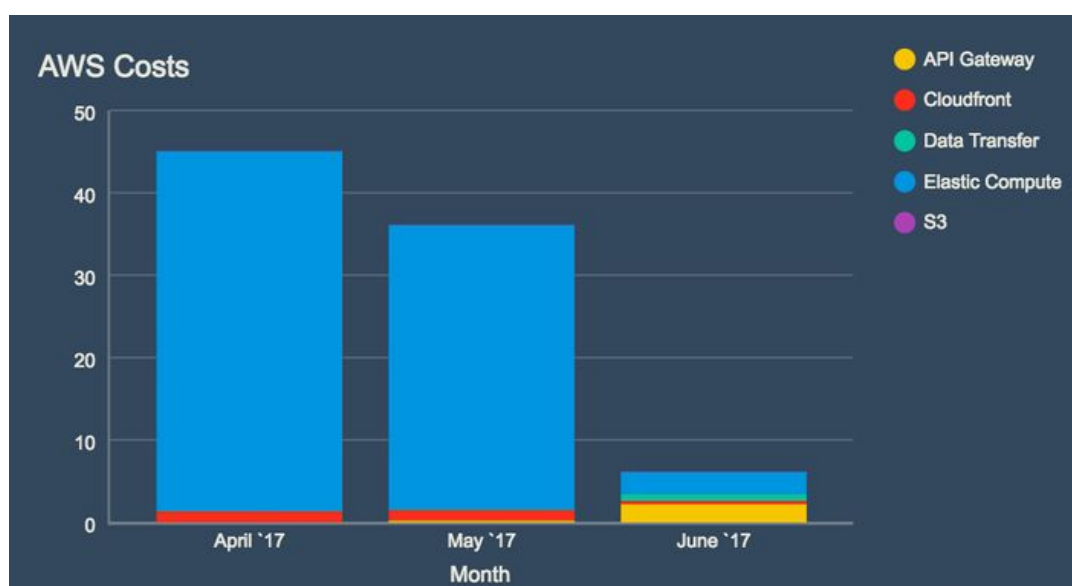


Figure 5- Cost saving in June after leveraging serverless technology (API gateway in this case) Source: Libhiv

Secure Cloud-Connected Device

To make sure only authorized cloud devices can connect, EnGenius Cloud uses MFA (multi-factor authentication) to add an extra layer of protection in addition to non-sequential serial numbers and MAC address verification. After a device is authenticated, a secure tunnel is established between the device

and the cloud with a unique certificate provided by the EnGenius Cloud to encrypt transmissions. Even if the EnGenius Cloud goes down, cloud devices will work as normal to securely transmit data from switches and access points, with the only downside being a temporary loss of ability to change device configuration on the cloud service.

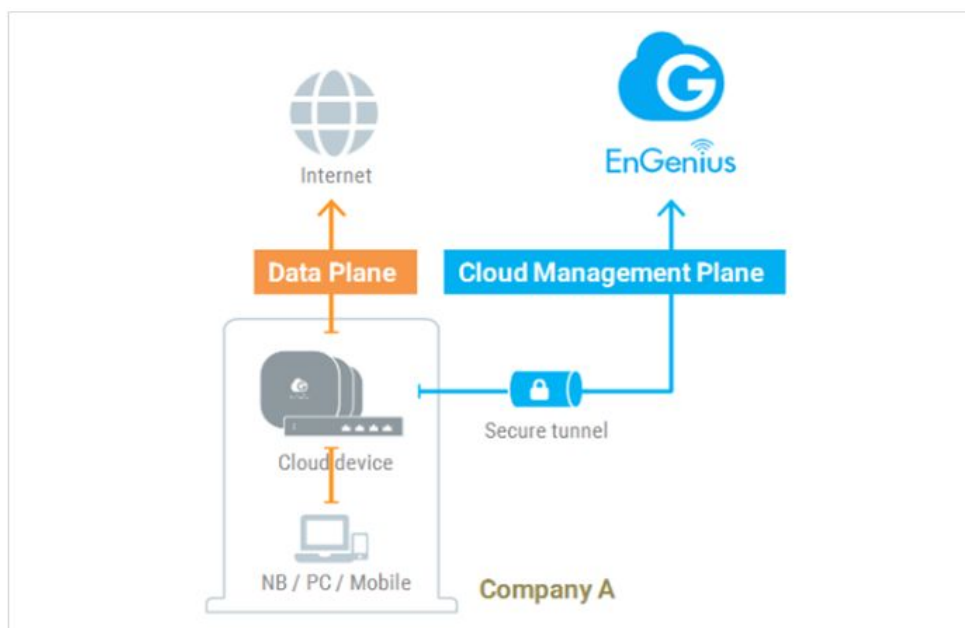


Figure 6- Secure tunnel for management plane

Plug and Play - Easy to Manage Remote Office

For EnGenius Cloud implementations, the network administrator at HQ simply needs to configure network settings, register devices by scanning the QR code with the mobile app, and assign the registered device to one of the networks on EnGenius Cloud. The device can be shipped to a branch office, and once plugged in, EnGenius Cloud will push the proper configuration to the device and work as intended.



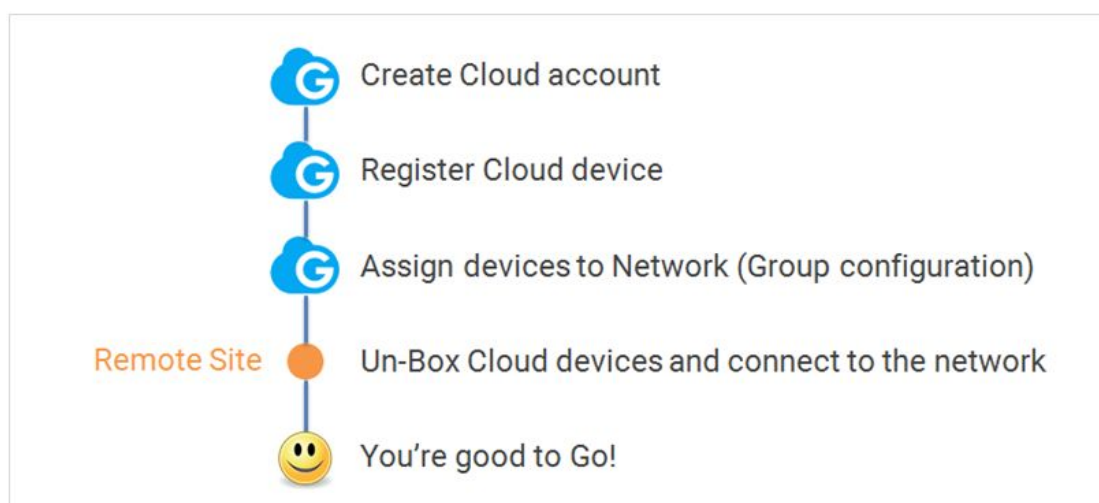


Figure 7- Simple steps for Plug-and-Play in EnGenius Cloud Solution

Even when the device fails, any member of the branch office can RMA the device locally and simply let HQ know the serial number of the now-replaced device. A replacement device can be plugged in and will work exactly the same as the previous. No professional visits or messing with local device configuration is required.

EnGenius Cloud – Basic Structure

Organization - Network - Hierarchical View

The EnGenius Cloud consists of three essential components: organization, networks, and hierarchical view (HV).

- **“Network”** refers to a group of cloud devices (AP or switch) under the same group configuration.
- **“Organization”** contains the inventory list of all devices registered within the organization under a single license.
- **“Hierarchical View”** (HV) Layer: Group of Networks and HV’s

In some use cases a company may have a complex branching network hierarchy, including a combination of central IT management with total access privileges and regional IT teams with siloed network access. In this case, EnGenius Cloud defines the hierarchical view level as a multi-layered group of networks. An MSP can own a license under the MSP’s organization,

create a first HV layer for managed-service tenants, and then create additional layers with accounts for tenants to access the tenant HV and networks by themselves. The example below explains how a MSP Company creates a first HV layer for tenants A, B, and C. Under each tenant, there are both US and EU regions, and more branch offices under US and EU, so the IT managers in the US region of tenant B can only manage for the US region.

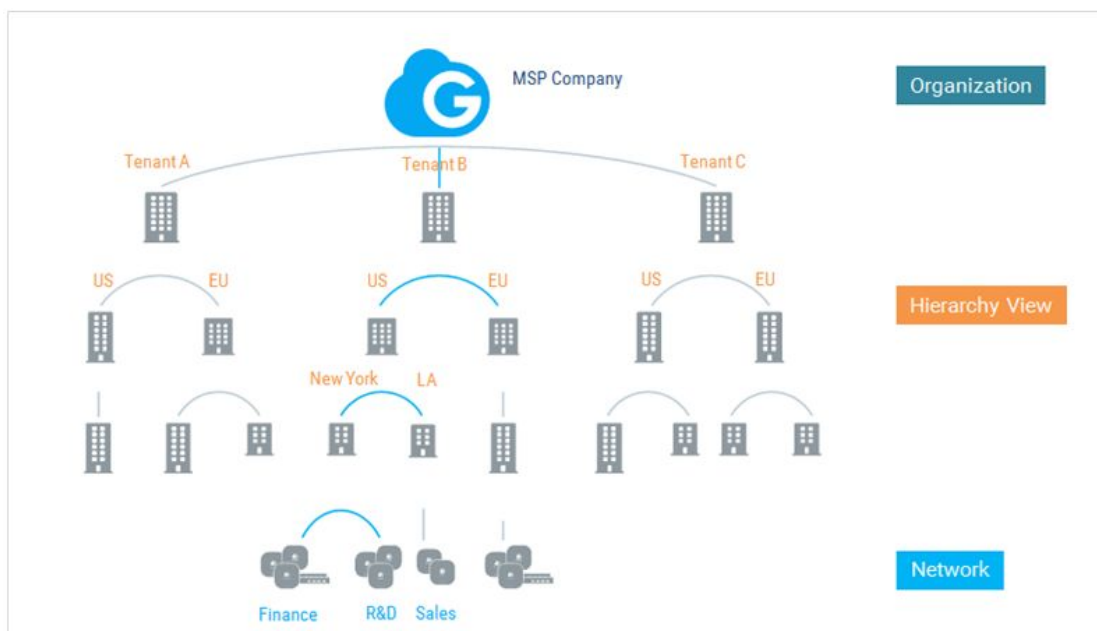


Figure 8 - Cloud design structure of a multi-tenant MSP company

Multi-User Privilege

There are 2 basic user roles: *administrators* with full access privileges and *viewers* with read-only privileges. There are 2 levels for these roles:

Organization and Network:

- Organization Level: has the highest permission in the Cloud and is the only person to manage licenses and full inventory control.
 - Two administrators are highly recommended to prevent email lockouts
 - Administrator email is recommended to use the same domain as the company domain, so administrator activation and notification can only be received through the company email server

- **Network Level:** has the permission to access a specific network and devices under the network.

There is no need for separate Hierarchical View privileges, since HV is a group of other HV's and networks, so all permissions are based on the permission of networks the user has privileges to access. For example, a user with permission to access finance and R&D can see both the US HV and New York HV, but cannot access the LA HV and Sales Network.

If network support or consultants are required from outside the company, it's recommended to assign network level permissions only. Organization level has the highest privileges, including the ability to add/remove users and modify license information.

Visualize Your Network

Integrated ezWiFi Planner Completes the Cycle from Design to Result

EnGenius customers have been enjoying the subscription-free benefits of the award-winning ezWiFi Planner tool to plan their next network deployment by simulating the environment with obstacles and advice on the placement of AP's.

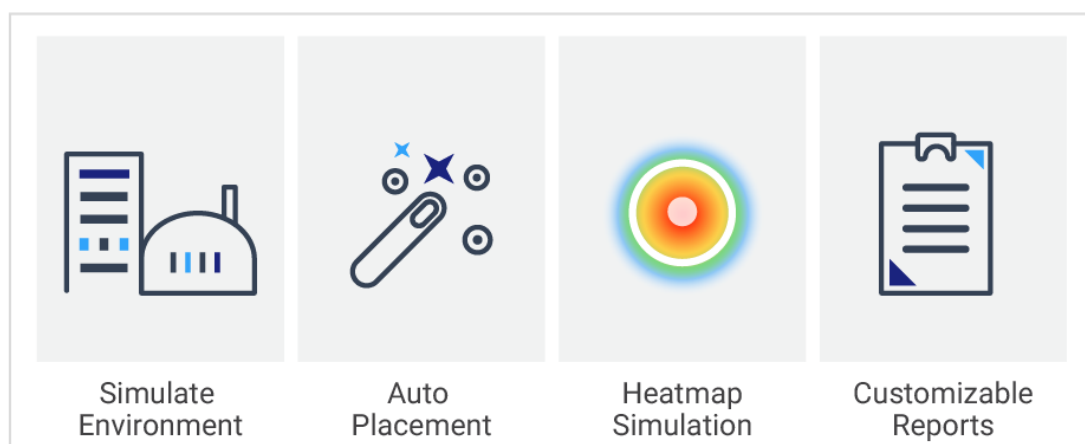


Figure 9 - Award-winning ezWiFi Planner simulates AP locations to cover required Wi-Fi areas

EnGenius is proud to announce that the ezWiFi Planner tool has advanced one step further with total integration into EnGenius Cloud. After using the tool to create an initial access point layout, users may now import the floor plans from ezWiFi Planner into the cloud. The virtual access points represented in the plan can be replaced with your real-life access points managed in EnGenius Cloud, where the channel and transmission power of the APs will be applied. (The channel and transmission power might be changed from time to time due to auto-channel, auto-RF, or other optimization algorithms.)

With the integration, there is no need to spend time redrawing wall obstacles or recreating other elements of your floor plan at a later date. EnGenius Cloud will recompute a heatmap of your layout and coverage with all obstacle interference considerations. EnGenius now completes the entire design cycle of plan, deploy, check, and adjust. To plan a Wi-Fi network with ezWiFi Planner, deploy the Cloud APs based on the plan and double check the Wi-Fi coverage based on real-life AP parameters and adjust accordingly.

While heatmaps are a feature available from many other cloud-based vendors, EnGenius Cloud provides a unique offering. Because EnGenius owns both the planner and the cloud platform, it is capable of drawing up more accurate real-world conditions in making its deployment assessments. Obstacles and congestion areas now play a greater role in predicting a coverage area as accurately as possible. This is in contrast to other heatmap software, which makes a naïve assessment of conditions when displaying its AP heatmap.

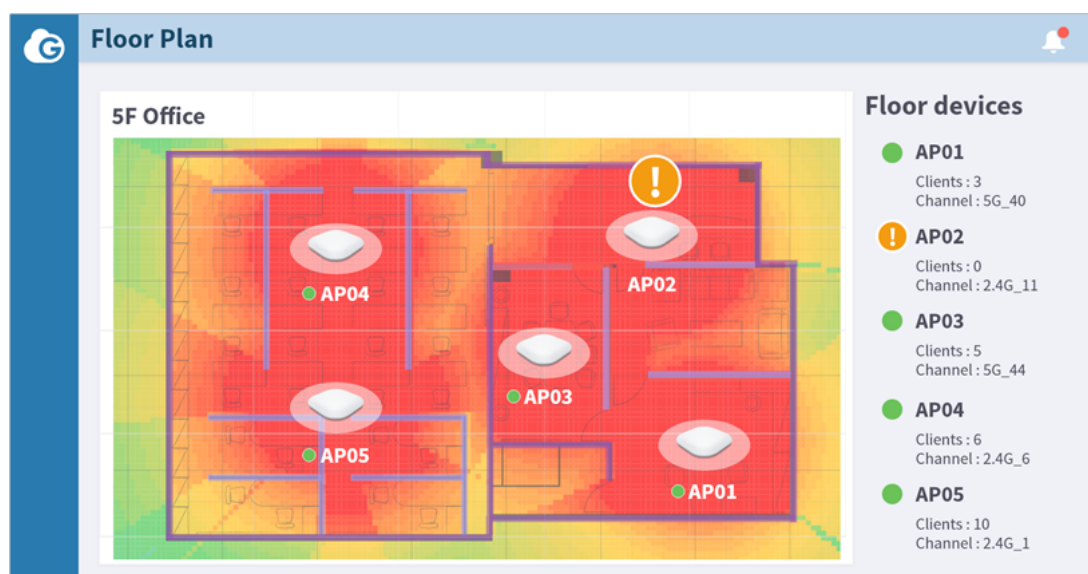


Figure 10 - Embedded heatmap tool in EnGenius Cloud

Some would argue that on-site site surveys should be preferable to developing real-life heatmaps with RF measurement. We agree 100%. There are many potential confounding variables in a deployment, such as RF interference from unknown sources, wall thickness, material variation, etc. However, site surveys require competent on-site tools and a thorough examination by a professionally-trained surveyor. This process consumes a lot of time and money.

Furthermore, if access points are set as auto-channel and auto-RF, then the survey results are less useful after transmission power and channel changes, because the site survey can only measure Wi-Fi as a snapshot in time. The EnGenius Cloud Heatmap tool allows you to compute a heat map using the most up-to-date conditions with a single click, at no additional effort and cost. The value of this tool is not to replace site surveys, but to enable a more informed decision about whether a full-site survey is justified.

Network Health Check at a Glance

IT managers must have constant updates about the status of their network. EnGenius Cloud Dashboard provides a holistic view of the network health check, with radar charts to create an overall score based on AP congestion rate, CPU/memory utilization, throughput, and other factors. IT managers can also track the number of devices and clients accessing the network and their status.

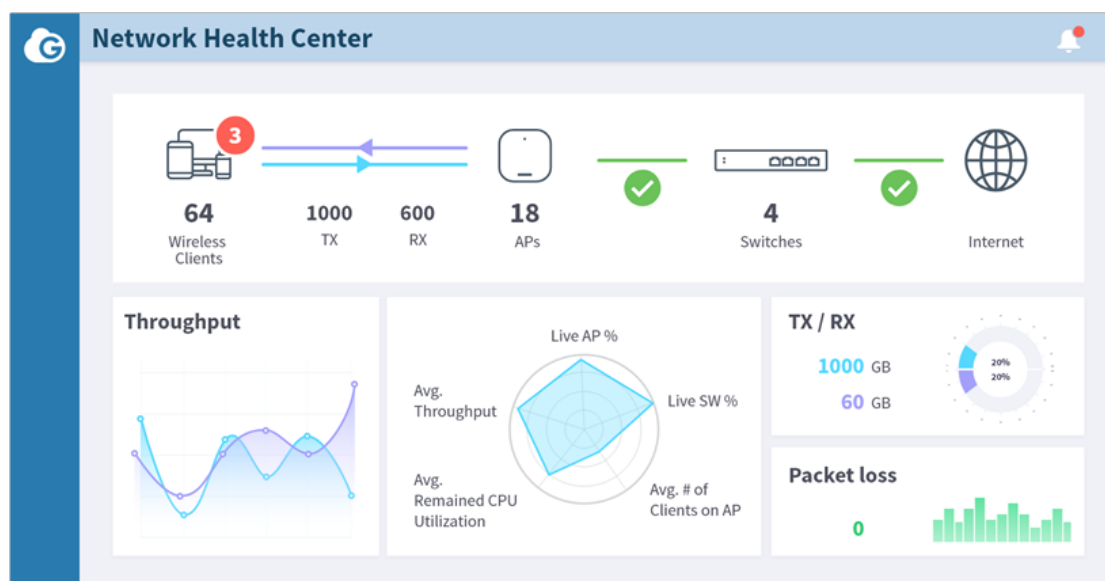


Figure 11- Holistic health check view of networks

When specific devices may have a throughput issue, a device list view (figure 12) can help IT managers quickly browse through each device's main information to pinpoint the potentially problematic device, review device details, and perform troubleshooting if necessary.

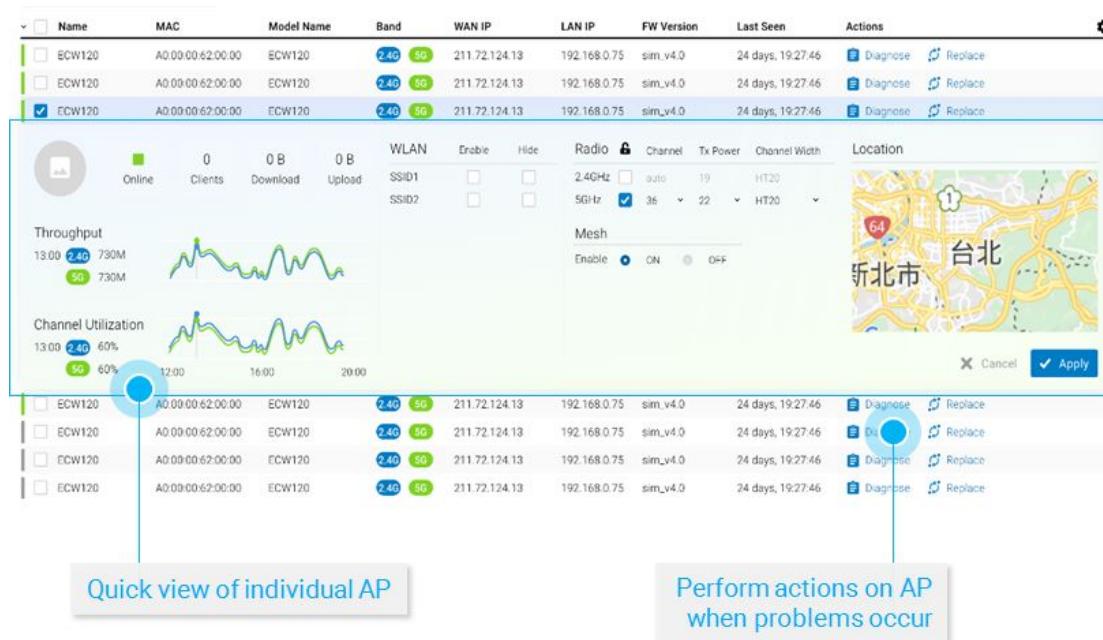


Figure 12- AP device list view with quick dashboard

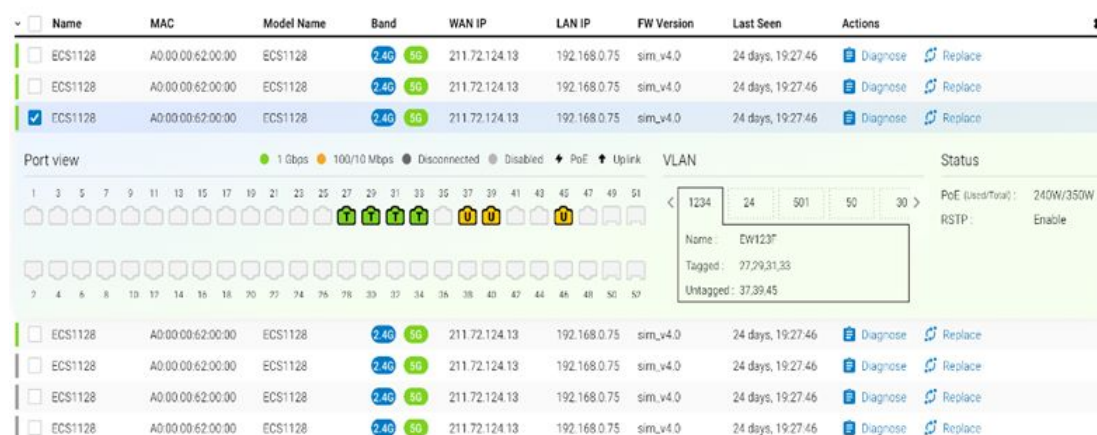


Figure 13- Switch device list view with quick dashboard

L7 Traffic Analysis

During periods of heavy traffic, IT managers should be able to quickly understand the application source of the traffic increase, such as video streaming applications, peer-to-peer, or web surfing. EnGenius Cloud access points have the Layer 7 DPI engine embedded to collect application traffic information right at the edge, eliminating the need to add an L7 traffic box to collect data and removing a potential speed bottleneck. However, deep packet inspection (DPI) consumes a lot of CPU power, typically resulting in a 15% decrease in access point performance. EnGenius Cloud allows you to toggle the L7 DPI settings (on by default) via the cloud if increasing performance is a priority.

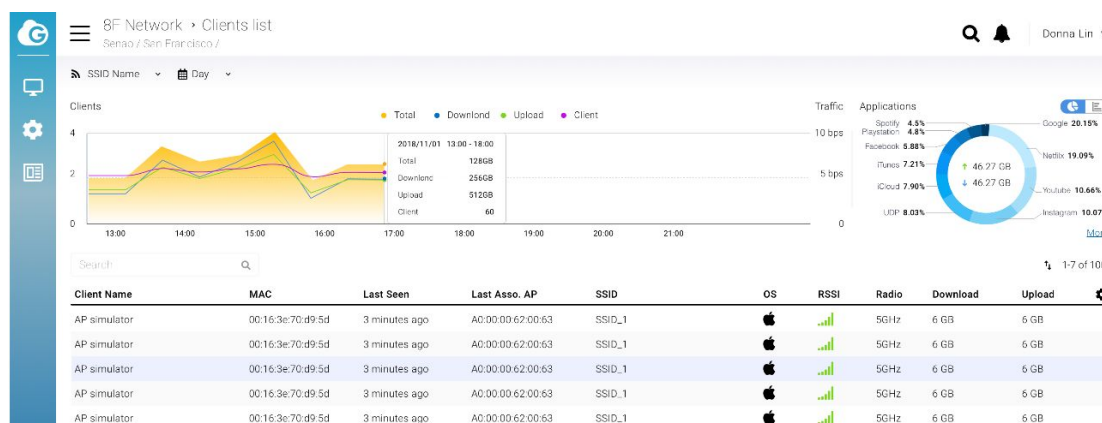


Figure 14 - Client list view with Layer 7 application aware traffic dashboard

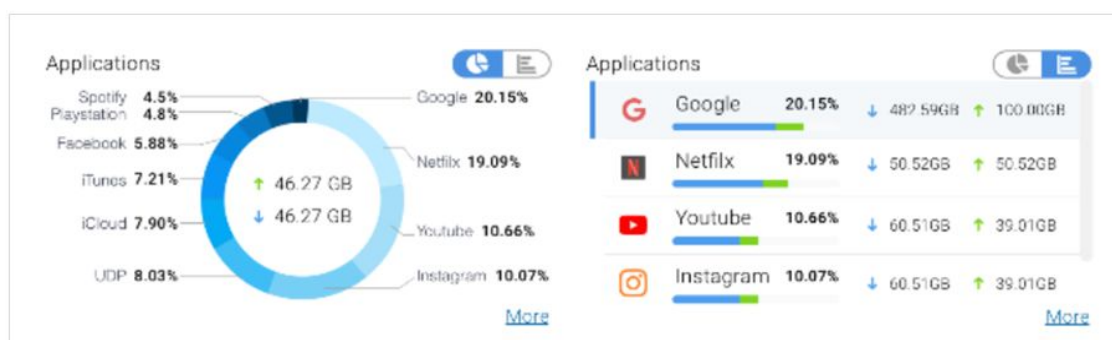


Figure 15- Switch device list view with quick dashboard

Topology View with Speed Test

EnGenius Cloud provides a topology view of any hierarchical view (HV) or network, to depict the relation between EnGenius Cloud managed switches and APs in a single overview. IT managers can, for example, locate a faulty switch switch port connected to a problematic AP to see if the issue is caused

by the switch. They can take action such as powering the switch PoE port on and off to hard-reset the problematic AP.

EnGenius Cloud also provides a tool to test the internet access speed of the device on the topology between the device and EnGenius Cloud, so an IT manager can determine if WAN speed or the LAN link issues are the source of the problem.

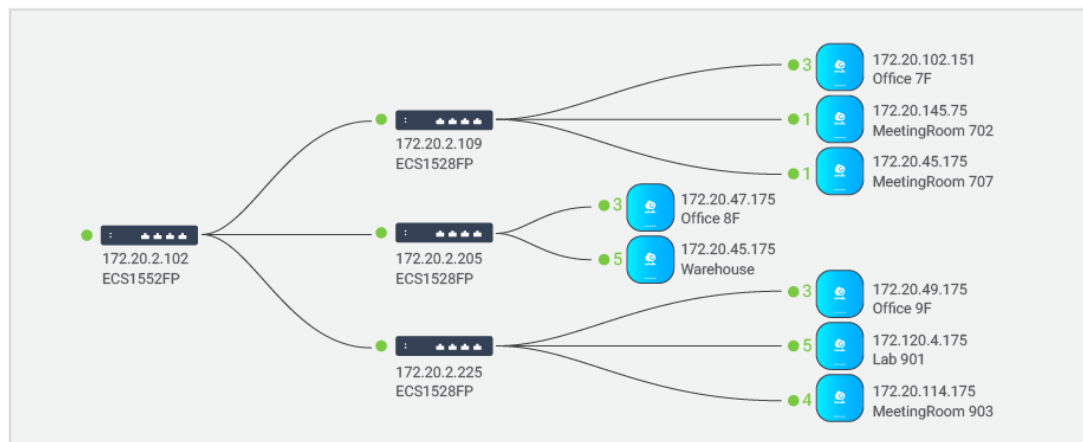


Figure 16- Topology View

Troubleshooting with In-Sight Visualization

One of the most difficult jobs for an IT manager is to diagnose a technical problem from the vague and non-technical descriptions of their customers. For example, the problem described as “cannot access the Internet” might have many potential sources and require different approaches to further investigate and respond correctly. EnGenius assists IT managers with information visualizations to resolve potential issues as illustrated below.

Wi-Fi Issues, Clarification Methods and Responses

- Client cannot connect to Wi-Fi
 - Possible Issue: RF issue from the client or AP
 - Clarification: Check AP throughput and real-time CPU/Memory through EnGenius Cloud AP detail page
 - If:

- AP issue: reset the AP or power reboot the PoE port of the switch
 - AP has no issue: ask client to restart the Wi-Fi module or reboot
- Slow/no Internet in specific area
 - Possible Issue: weak RSSI signal
 - Clarification: Verify the client RSSI signal strength on the associated AP, provided through the client list on EnGenius Cloud
 - If:
 - RSSI is low: either move/add AP for better RF coverage, or ask client to move to an area with better coverage
 - RSSI is adequate: could be an RF interference issue - further investigation is required by IT to rule out possibility of rogue AP or non Wi-Fi source through RF scanning.
- Slow or no Internet everywhere
 - Possible Issue: (1) Gateway or ISP WAN connection issue (2) overcrowded clients
 - Clarification: (1) Should run an AP speedtest through EnGenius Cloud (2) Check number of clients on the APs
 - If
 - AP speed test is slow: call ISP
 - AP speed test passes and clients number more than 20: add more APs with different channels to balance the load
- Connection drops randomly
 - Possible issue: RF interference or channel congestion

- Clarification: Check the channel utilization of the spectrum in the AP detail page
- If:
 - Channel utilization is high: change AP channel or investigate potential rogue AP.
 - RF status is good: IT should reset or power reboot the AP

EnGenius Cloud provides many In-Sight visualization features to help IT managers rapidly identify issues in a more effective manner than customer Q&A.

Client Timeline

EnGenius Cloud records each client's journey in the network with timestamps. As long as the IT manager knows the client MAC or serial number, they can pull up that device's entire history on the network. This includes which AP it connects to, authentication status, and the time required to roam to the next AP.

In one such case, the client has associated and authenticated with AP01, but failed in associating with AP02 SSID02. AP02 most likely has seen the device, but the client's transmission power could be too low to send the packets back to the access point properly.

Historical Statistics Dashboard

When there is a specific AP identified with potential issues, the historical throughput statistics dashboard will help IT managers visualize any abnormal traffic patterns degrading network performance. Here, the L7 traffic dashboard lets us see what application takes up the most traffic:

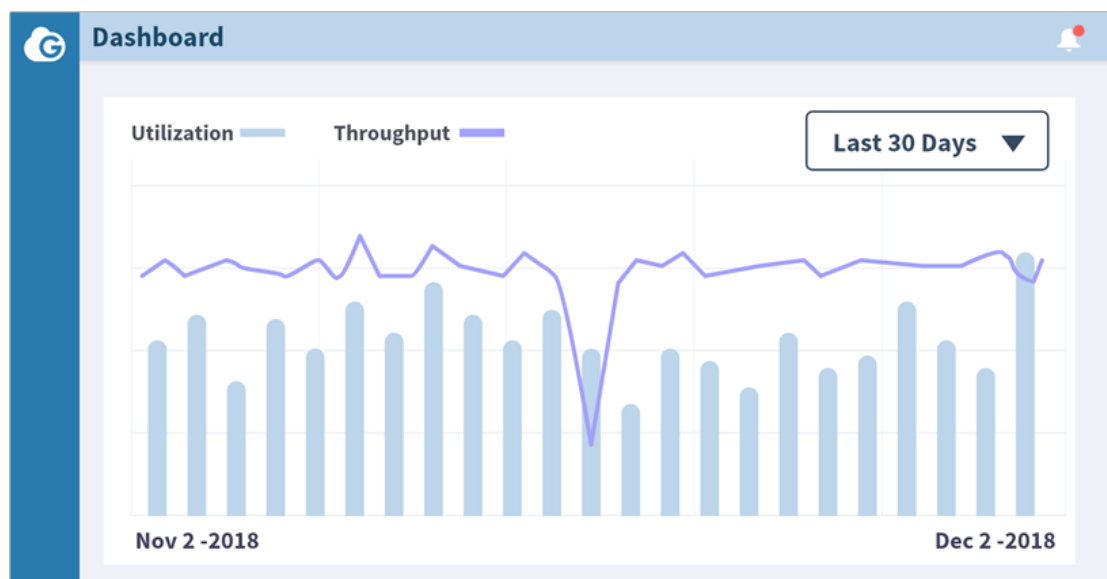


Figure 17- Throughput and utilization view

Real-Time Status of Cloud Devices

Slow network performance can be very likely caused by high CPU or memory utilization by networking devices. EnGenius Cloud will invoke a “real-time function” module, building a specific tunnel to observe the CPU/memory utilization rate in real-time. When real-time device information and throughput is compared to historical statistics, then IT managers can decide whether they should reset the device or just monitor for future issues.

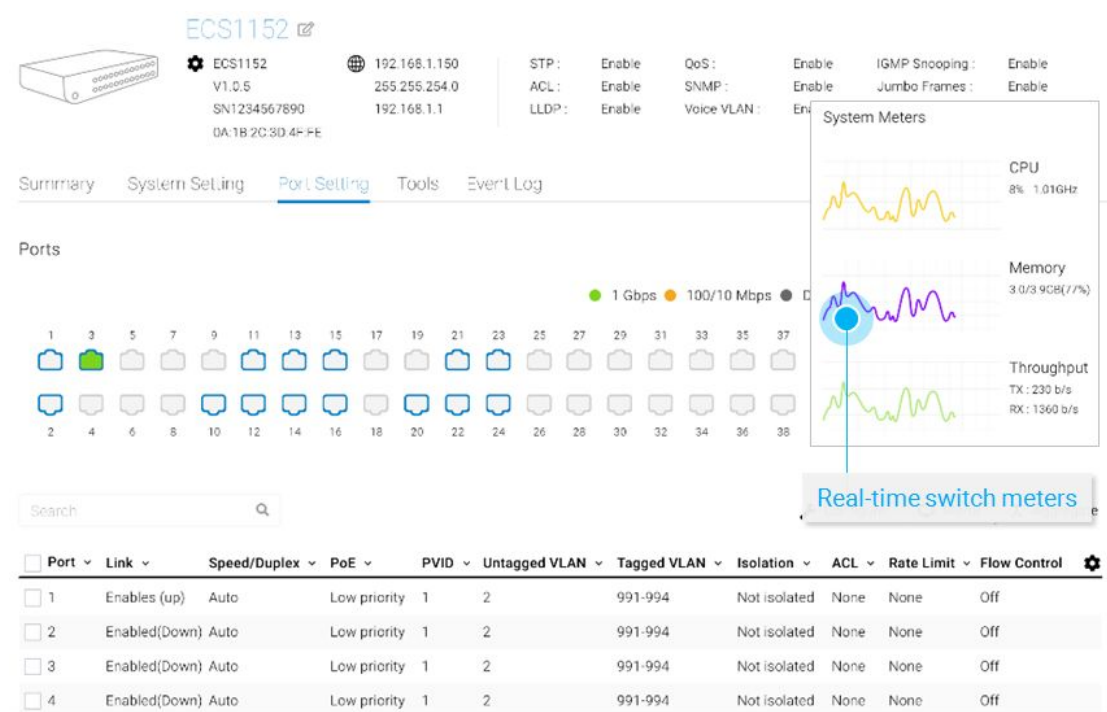


Figure 18- Real-Time CPU and Memory of a switch

Comprehensive Event Log Report

One of the biggest headaches for IT managers is to piece together threads of an issue from disparate log files across one or more machines in a network. EnGenius Cloud automatically consolidates all log files in a single convenient location, including system log, event log, and configuration changes of all managed cloud devices. Powerful filtering functions empower IT to compare and analyze the logs for many different devices and cloud configurations, filtering by time period, event type, network, SSID, specific device or client, categorizing event states as error, warning, or general state.

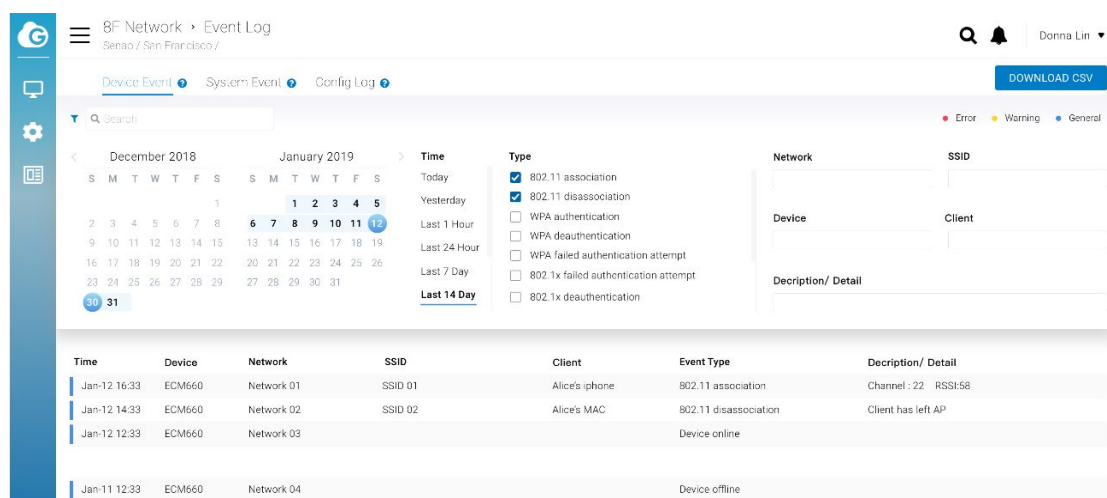


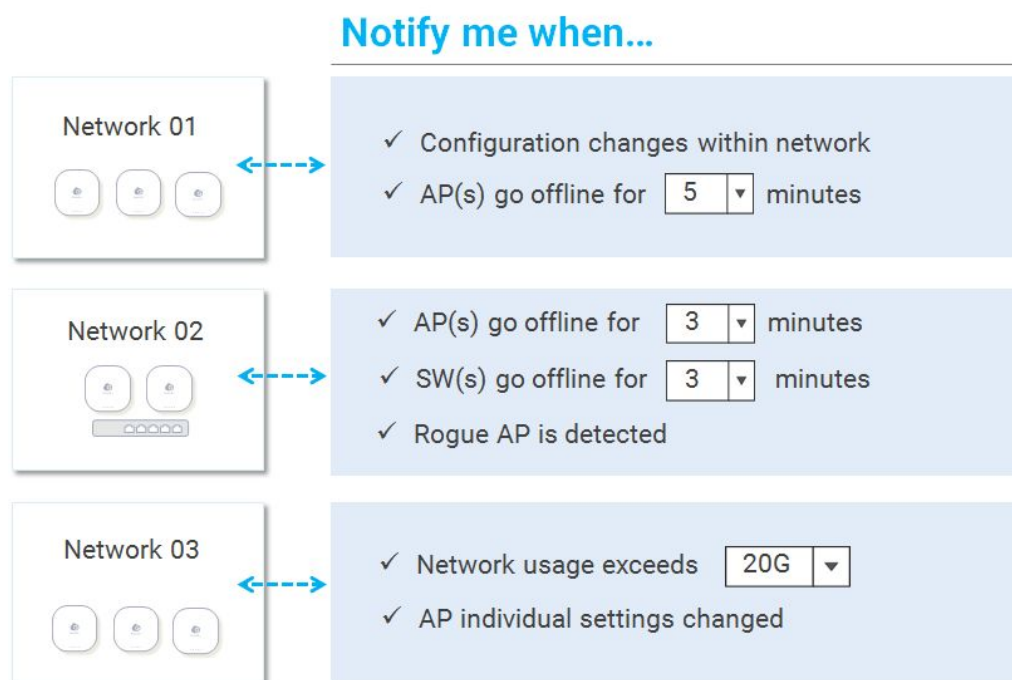
Figure 19- Centralized event log report with powerful filtering function

Customized Notification per Network

Staring at network statuses all the time is not an effective use of an IT manager's time. An effective notification system through email or via mobile phone saves time in pinpointing where a network problem is occurring, at exactly the moment that it occurs. At the same time, the notification system has to be well-designed so as to not flood your IT team with false notifications that they grow accustomed to ignoring.

EnGenius Cloud enables users to customize their notification criteria per network base. There might be hundreds of thousands of network notification scenarios to be matched and sent to multiple recipients in a network. To make sure that recipients won't miss critical notifications and won't be overwhelmed by too many notifications, EnGenius leverages stream

processing technology to build a highly scalable, full fault-tolerant, secure and low-latency messaging platform to send the most important notification messages to the right people.



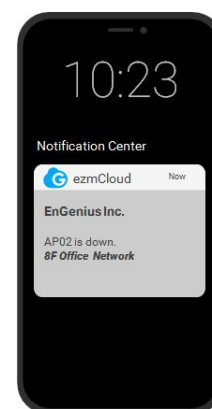
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Figure 20 - Rule-based notification customized by network

Manage your Cloud on the Go

EnGenius Cloud provides a mobile application to help users stay on top of their network no matter where they go. Users can be notified if something goes wrong with the network, then use the app to see network status and pinpoint potential problem source areas.

User can also use the app to register cloud devices by simply scanning the QR code on the backs of devices. They can then assign the device to a specific network, and the default network configuration will be pushed automatically to the newly-installed device.



API for MSP and Eco-Partners

EnGenius Cloud provides a complete set of APIs for MSPs and Eco-Partners to extend and customize the capabilities of EnGenius Cloud. We provide the flexibility to change the theme, frontend design, add on modules, traffic redirection, and even add new IoT devices, all in one convenient place.