Relay2

Cloud Wireless Networking & Beyond

WHITE PAPER

Whitepaper Contents

Executive Summary

In 2015, WiFi celebrated its 25th birthday. Over those years, WiFi has radically changed our lives extending from personal use at home to an essential tool for businesses. With more and more devices demanding connectivity and new uses emerging everyday, the need for increased coverage and faster speeds has never been greater.

Meeting such demand requires deploying next-generation Wi-Fi networks that equally provide performance, scalability, flexibility, and manageability. This paper looks at Wi-Fi's past, present, and future trajectory. And explores how Relay2's native-cloud WiFi solution provides the platform for both today's and tomorrow's wireless uses.

Background & History

Over the past 25 years since Wi-Fi was introduced, connection speeds have increased from mere megabits to multi-gigabits per second. Along with increased speeds there has been an exponential rise in WiFi-enabled devices with almost all mobile devices and computers including Wi-Fi by default and soon everything will be connected. A key factor in supporting the increasing uses, demands, and throughputs of WiFi is the network architecture. In this regard, WiFi deployments initially evolved from architectures of standalone access ponits to centralized hardware based controller architectures as shown in Figure 1. The hardware controller centralized control and coordination processing. And while, on-site hardware-based controllers enabled new WiFi functionality such as mobility and network optimization, it also introduced significant issues as more WiFi devices connected:

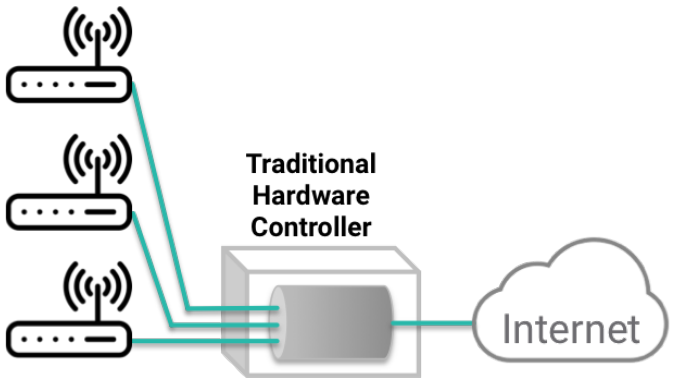


Figure 1. Hardware Controller

Resilience: One obvious problem, as illustrated in Figure 1, a single point of failure can occur with the use of traditional hardware-based WLAN controllers. Because both the Control and Data paths from APs flow through a hardware-based controller, any errors or the controller's failure will cause the entire wireless network to fail. This issue can be alleviated with fault-redundant hardware, but comes with significant added equipment expense for the network.

Performance Bottleneck: The second obvious problem is that with increasing WiFi traffic and link speeds, traditional hardware-base WLAN controllers introduce a performance bottleneck and adds unnecessary latency to the network.

Scalability: Third, traditional hardware controller can't scale on-demand. Adding or changing capacity requires the physical replace-

ment or upgrade of on-site equipment, which comes with equipment and deployment expenses. As such, dedicated hardware controllers must be statically dimensioned for a target capacity. Hardware controllers dimensioned for anything below peak conditions cause bottlenecks as described above. Conversely, hardware controllers dimensioned for peak conditions are overkill for typical traffic. As such, the excessive hardware controller horsepower adds significant capital expense that gets wasted during typical daily operations.

Manageability: Fourth, hardware controllers are complex to manage. Hardware controllers are deployed and managed as monolithic entities. Enterprises and service providers operating multiple networks must do so in a piecemeal non-centralized manner.

To address some of these issues, some vendors adapted their hardware controller based architecture shifting functionality out of dedicated on-premise hadrware controller appliances. One option virtualized the controller for operation in a cloud datacenter environment. This eliminated issues related to scalability and reliability. However, because such solutions are rooted on legacy functionality that assumes on-premise implementations, there are inherent limitations including performance degradation resulting from latency in processing dynamic events related to mobility and load balancing as well as network inefficiencies resulting from data forwarding of user traffic between access points and centralized controller implementations. Another option integrates controller functionality into an access point. While eliminating hardware expenses, this approach still suffers from issues related to performance, reliability, and scalability.

Relay2 Native-Cloud WiFi Networking

Taking all these issues into consideration, Relay2 started from the ground up to implement a native-cloud wireless controller. This adds the benefits of centralized management and coordinated control, but without the inherent limitation of on-site hardware-based controllers or associated adaptions. The Relay2 Cloud Service Manager is offered as Software as a Service (SaaS) providing network administrators with services including WLAN provisioning, monitoring, controlling, and RF optimization via a web console without the need to procure or install any server software.

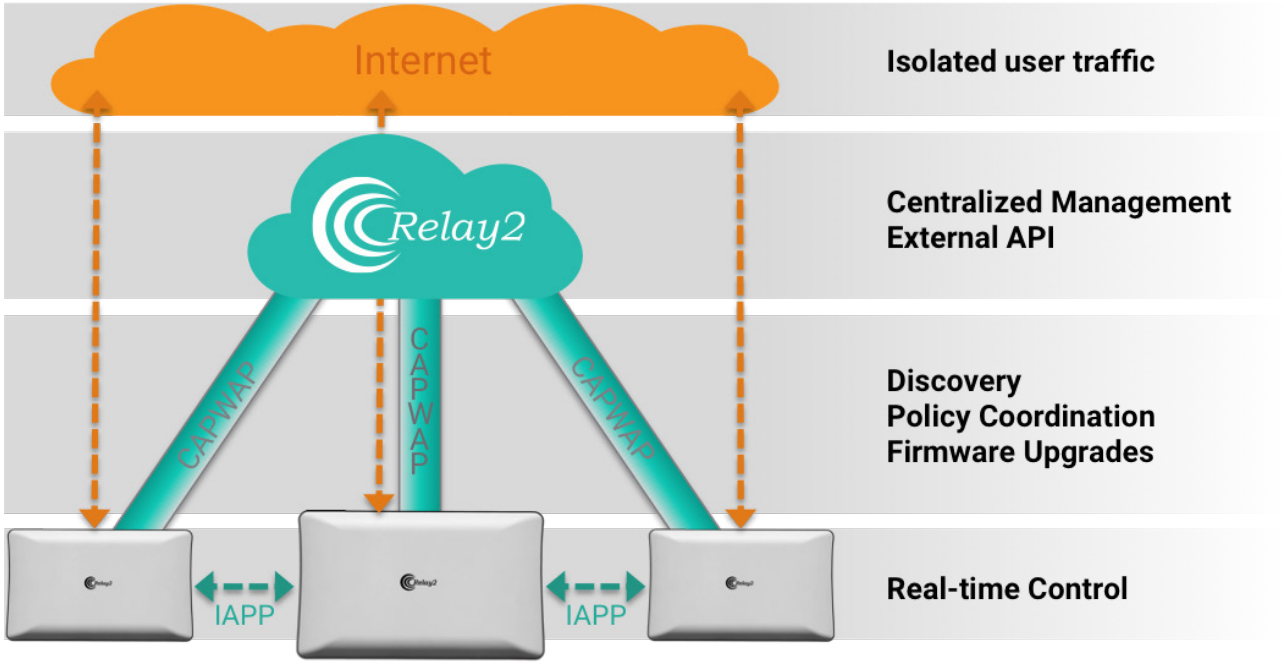


Figure 2: Relay2 Cloud Wireless Networking Architecture

The Relay2 cloud solution is architected to optimally distribute the control functionality between access points and cloud so that functions associated with highly dynamic processing are performed on a coordinated basis directly by access points at the edge of the network – thereby minimizing latency. Functions requiring less dynamic processing are performed on a centralized basis in the cloud. By splitting functionality, access points are not reliant on a distant centralized controller – even in the event of lost connectivity between AP and the cloud, networks can continue to operate and users maintain connectivity.

Coordinated Edge Control:

Taking advantage of improvements to computational power and economics of processors, Relay2 Access Points are sized to support highly dynamic functions traditionally supported by on-premise hardware controllers. These include data forwarding, encryption, load balancing, and roaming. By processing load balancing and roaming in the AP, the network can respond in real-time to dynamic changes in network conditions.

However, to achieve scalability and network optimization, AP operate in a coordinated manner. Coordination is enabled using communication between AP in a mobility domain. The Relay2 Inter AP Protocol (IAPP) enables neighboring AP to exchange messages pertaining to load balancing, roaming, guest WLAN, and RF optimization. By distributing and coordinating such dynamic controller functionality across AP in a network, the Relay2 solution achieves advanced network functionality while inherently incorporating scalability and resiliency into the architecture. As discussed in further detail in a later section, affordable AP processing not only enables distributed control functionality, but can also be power advanced and customized hosted edge applications.

Because the AP handles data forwarding, the Relay2 architecture can support a complete separation of the data plane, carrying user traffic, and control/management planes. As such, beyond the Relay2 access point, traffic can optimally be routed both within the LAN and beyond to the WAN. This provides bandwidth and latency efficiencies as user traffic, which makes up the majority of traffic from WLANs, does not need to routed via a central cloud. It also provides security benefits, as private data can be contained to a protected LAN environment. Furthermore, doing so eliminates the single-point of failure associated with hardware controllers. In the unlikely event of failure in the cloud, APs will continue to deliver user network traffic without compromising the on-site network.

Centralized Cloud Control & Management:

The cloud hosts controls functions that require centralization and less real-time processing – such as policy coordination, authentication, etc. In addition, to control functions, the Relay2 cloud also hosts centralized management capabilities. As with other cloud-computing resources, the Relay2 Cloud Controller can be scaled on-demand in response to changes in the number of customer, networks, and deployed access points. Relay2's plug-and-play APs automatically discover and associates to the cloud. It then automatically downloads configurations and predefined policies from the cloud and self-provisions making it immediately available for management and use.

The Relay2 cloud is instantiated across multiple regional datacenters providing support for global operations, seamless fail-over, and geographic redundancy. APs automatically associate to a particular cloud datacenter during initial boot based on region. AP can be redirected to alternate regional datacenters or self-direct when the associated datacenter is not responding.

Figure 3: Relay2 Regional Datacenters

The Relay2 cloud architecture is composed of five essential elements:

Cloud Control End-Point: A modified extension of Control and Provisioning of Wireless Access Points (CAPWAP) is the underlying protocol used in the Relay2 cloud networking architecture. CAPWAP provides a secure and streamlined method of communicating between Relay2 access points and the Relay2 cloud controller for the configuration and management of WLANs. The protocol was modified to facilitate optimal discovery and operation in a WAN environment. CAPWAP is secured using DTLS (Datagram Transport Layer Security) to prevent eavesdropping, tampering, or message forgery. The cloud control end-point securely processes messages including AP discovery, authentication & association, configuration, management, and firmware distribution.

Account Manager: The Relay2 Cloud Service Manager is a multitenant platform that provides secure and hierarchical account management for service providers and their customers.
To facilitate the management of thousands of AP across multiple service providers, customers, geographic locations, and logical networks, an Account Manager provides an interface between the per-AP Cloud Control End-Point and per-account network management web interface.

Web Interface: A vital part of operating large and distributed networks is centralized and intuitive management interfaces. An external web-facing management system provides a browser-based UI providing easy navigation for users to configure, monitor, generate report, and issue commands for the WiFi networks and its associated access points. The management system can be access from anywhere around the world without any special software client installations. The Relay2 Cloud Service Manager offers feature-rich graphical user interfaces such as an at-a-glance dashboard view for current status of deployed APs. Even with a rich enterprise feature set, an intuitive provisioning page helps administrators con-

figure RF properties and WLAN policies. Administrators can take advantage of monitor and statistics views to identify the status of WLANs as well as the wireless client and traffic distribution in real time. The Relay2 Cloud Service Manager also provides numerous customizable reports of wireless client statistics and configuration changes so that the enterprise IT staff can easily keep track of the changes made and adjust them if needed.

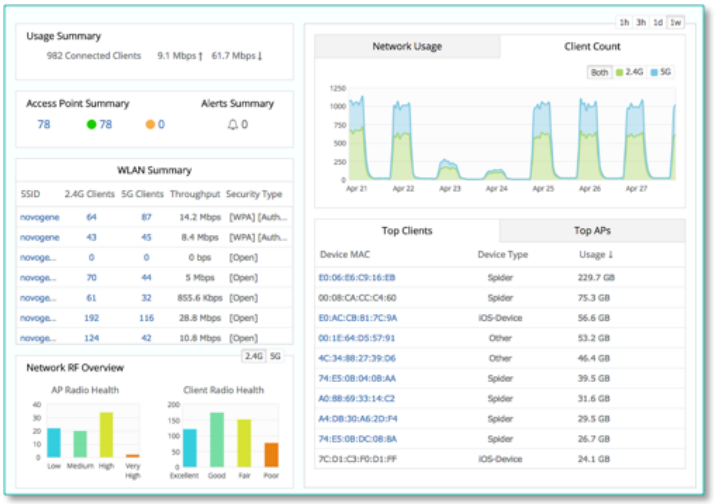


Figure 4: Relay2 Cloud Dashboard

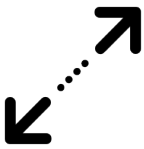
A single management account can manage networks across multiple locations, branch offices, and buildings. Furthermore, multiple users of a single account may log into the management UI from different locations - visibility and control permissions are fully controllable based on role definitions.

Web-Service API: In addition to managing large and distributed networks via the browser-based GUI, Relay2 network management supports a suite of RESTful Web-Service API (WS-API). The WS-API enable external system secure and extensible access to monitor and manage networks. Functionality accessible via the WS-API includes (but is not not limited to):

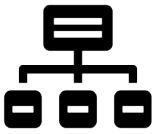
- Request customer account list
- Request access point list
- Request WLAN list
- Request WLAN configuration
- Add/delete/enable/disable WLAN(s)
- Configure WLAN (radio policy, security type, ACL policy, etc.)
- Add/change/delete RADIUS
- Request client data
- Disconnect client station

Relay2 Cloud WiFi Networking Benefits

Implementing a native cloud solution that splits functionality between distributed and coordinated AP intelligence and centralized cloud control and management offers multiple benefits:



Scalability: Relay2 provides highly scalable coverage to support thousands of APs across hundreds or thousands of networks. Expanding coverage to existing managed wireless networks is as easy as simply adding additional plug-n-play AP. Because of the distributed control functionality within each Relay2 AP, as new AP are added to location's network, it provides not just additional coverage but additional control processing power such network can scale to any size.



Manageability: With no hardware controller connection boundaries, Relay2 can deploy their APs across multiple distributed or remote sites. Plug-n-play AP streamlines the deployment and provisioning of large and remote networks. The Relay2 Cloud Service Manager provides a truly centralized management environment, which can streamline policy enforcement, configuration, and monitoring over a distributed, large-scale network. Service integration and feature upgrades are made seamless via centralized management.

Affordability: By providing the controller equivalent technology as a SaaS offering, Relay2 cloud WiFi networking significantly lower Total Cost of Ownership (TCO) by converting the CAPEX (Capital Expenditure) of a hardware controller into OPEX (Operating Expenses) of a service subscription. For end customers, Relay2 allows for the outsourcing of WLAN management services creating additional financial benefits. Value-added resellers or service providers can create recurring revenue from offering a combined AP & clud solution as an ongoing service.

Reliability: By associating each AP on a individual basis with geographically redundant cloud datacenters, the Relay2 cloud architecture eliminates any single point of failure. The Relay2 Cloud Service is hosted in multiple data centers around the world providing a level of availability that is impossible with traditional hardware controllers. In addition, Relay2's cloud architecture provides out-of-band control to ensure that the network functions and APs continue to operate even if Internet connection goes down.

Security: The Relay2 cloud solution was built with uncompromising end-to-end security. From APs to the cloud and the communication in between, the Relay2 solution benefits from the following security considerations:

Client Traffic Isolation: The Relay2 AP and Relay2 Cloud Service Manager separates traffic from wireless clients from control and management traffic. User traffic (such as email, web browsing, application, etc.) is never passed to the cloud controller and is contained within the customer's local network or routed directly to the target destination.

Out-of-Band Cloud Controller Path: The Relay2 Cloud's out-of-band controller path separates AP management data from user traffic. Cloud controller management data (including configuration, monitoring statistics, etc.) flows between AP via a secure internet connection.

Encrypted Control Messages: All out-of-band control and management traffic between AP and the cloud flow via a secure connection. Specifically, DTLS protects all messages between AP and the cloud controller from eavesdropping, tampering, or message forgery. All IAPP control messages between coordinating AP are secured.

Role Based Access - The Relay2 Cloud Service Manager offers various account access roles. Each account role is associated with a different managerial view and capability to fit the need of the enterprise IT administration requirement.

Datacenter Security – Relay2 service is hosted in state-of-the-art SSAE 16 Type II and SOC2 Type II certified datacenters featuring world-class physical and networking security. Extensive physical security includes multi-stage biometric entry and 24x7 on-site security and surveillance. Networked services are monitoring 24x7 with automated intrusion detection and prevention, and are protected via IP and port-based firewalls.

Comprehensive Cloud Services

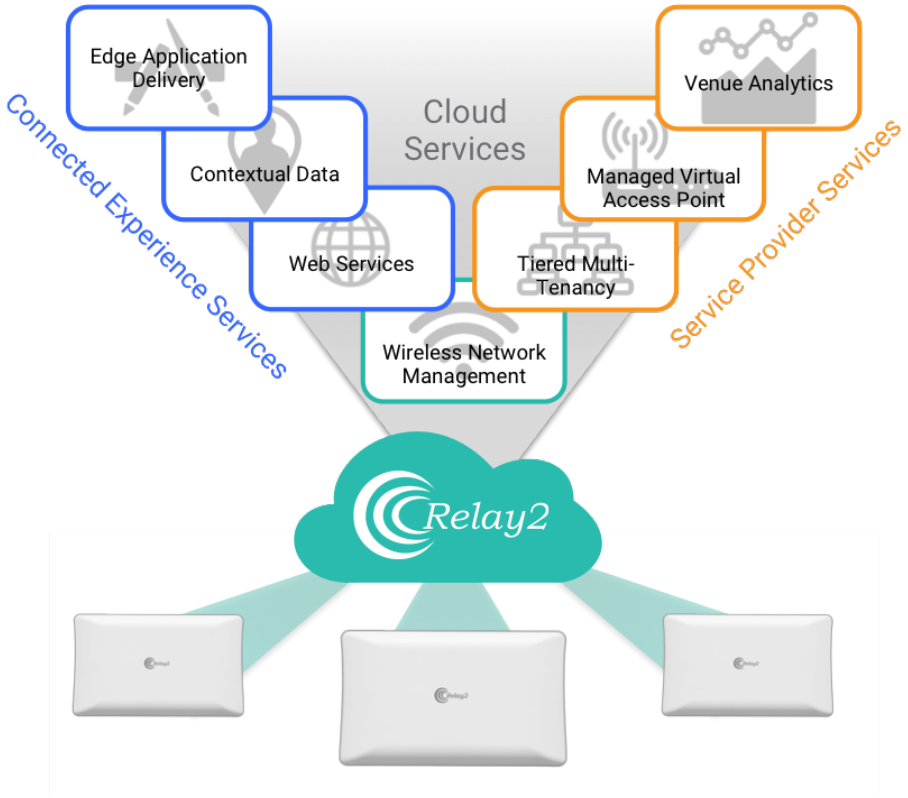


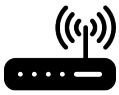
Figure 5: Cloud Services

In addition to centralized control and wireless network management, the Relay2 cloud supports a suite of advanced cloud services that provide enhanced features and functionality. These include Service Provider (SP) cloud services and Connected Experience (CX) cloud services.

Service Provider (SP) cloud services are well suited for managed service operations and include:

Tiered Multi-Tenancy: With tiered-multi tenancy, the multi-tenant Relay2 platform provides secure and hierarchical account management for managed service providers and their customers. The tiered cloud management platform offers easy graphical traversal flow for the service provider to manage and monitor its AP customers including customer account creation and management, while,

at the same time, allowing the end customers to plan and monitor their own WLAN network anytime, anywhere, and from any web browser.



Managed Virtual Access Points (MVAP): MVAP enables a single AP infrastructure to be virtualized into multiple (up to 8 per AP), individually managed WLAN. The management system supports the creation of MVAP Service Providers (SP) and MVAP tenant accounts. MVAP SP manage the physical infrastructure as well as tenant accounts including allocation of tenant WLAN to particular APs. MVAP tenant accounts are given control and visibility of their WLAN including network policy and security settings.

Venue Analytics: Venue Analytics provides an easy and quick way to gain business insight across venues and properties. It provides easy to understand metrics, such as number of visitors, repeat customers, dwell time, so venue managers can learn their customer behavior, improve their business operations, and increase sales. The metrics are stored in the elastic Relay2 cloud and are presented over a highly visualized and intuitive graphical interface. Users can easily customize their data to gain insights for their needs. For example, users can view metrics for a durations of their marketing campaign period to evaluate the effectiveness of their marketing campaign. When combined with the Contextual Data Feed service (see below), Venue Analytics allows users to export the venue metrics to 3rd party systems for more extensive analytics.

Connected Experience (CX) cloud services are well suited for enabling rich connected experiences on top of high performance WiFi in guest/customer facing environments, These cloud services include:

Web Services: To optimize the mobile web experience for connected users, web services provides administrators the ability to configure web caching and HTML insertion capabilities. Web caching enables the AP to dynamically store bandwidth intensive or popular web content in order to improve the user experience, especially in

high density environements. HTML insertion enables AP to configure overlay ranging from static banners to dynamic menus in-line with web content. This is achieved without the need for proxy redirection to an on-site appliance or cloud-hosted service.

Contextual Data Feeds: Networks can be configured to collect contextual data for connected clients that includes RSSI-based location information as well as client traffic information in the form of HTTP header captures. Contextual data are available via both edge and cloud API for integration into third party services.

Edge Application Delivery: Advanced or customized edge applications can be developed, deployed, and managed on the Relay2 platform with Edge Application Delivery (EAD). Whether a horizontal networking or security application or a vertical-specific solution service, developers can build applications using Relay2 SDK and API and then publish applications to the Relay2 cloud. Leveraging a container-based framework, applications can then be seamlessly deployed to a single AP or a network of thousands of AP. The Relay2 cloud provides visibility and the ability to control and configure applications.

Beyond Cloud Networking to Converged Edge Computing

By optimally distributing intelligence and processing between the edge of the network and the cloud, the Relay2 solution achieves the wireless network performance and functionality of traditional on-site hardware controllers without any of the short comings – resilience, performance, scalability, and manageability.

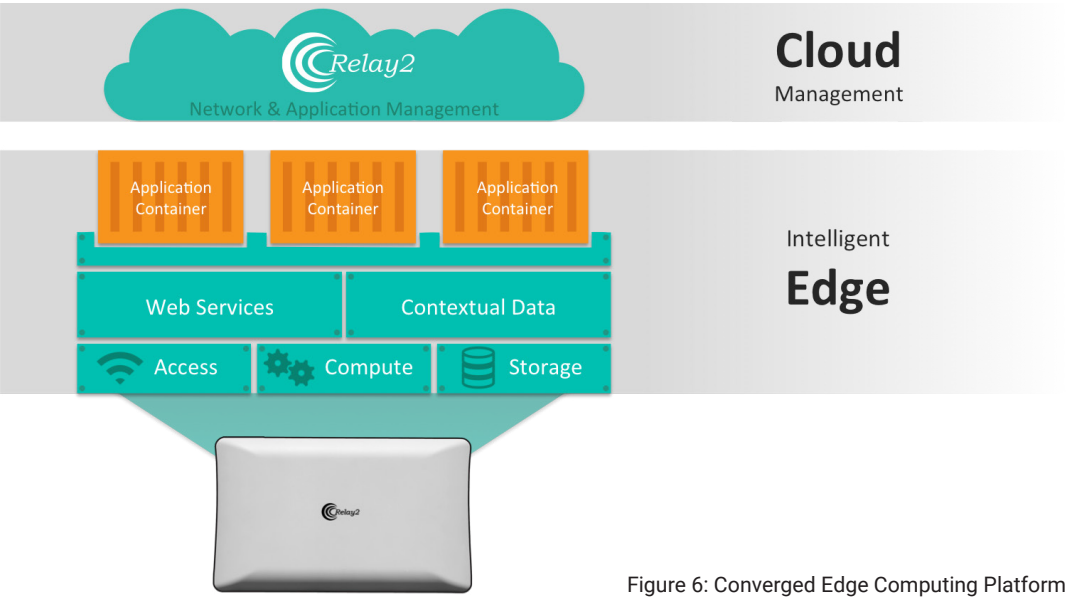


Figure 6: Converged Edge Computing Platform

The Relay2 solution extends this paradigm beyond networking. Leveraging the powerful on-board processor, the Relay AP offers a distribute compute capability that can be applied to applications and services beyond networking. Additionally, each AP is provisioned with dedicated on-board solid-state storage creating a distribute storage environment. As with the networking, Relay2 enables centralized management of both distributed edge compute and storage as well as the hosted edge applications these enable.

This converged approach to cloud management of distributed infrastructure enables innovative applications to be integrated with the wireless infrastructure. Existing applications including horizontal capabilities (VPN, Firewalls, IP-PBX, etc.) can be integrated to eliminate monolithic legacy systems. Or new innovative vertical specific solutions (realtime edge video orchestration, location based mobile engagement, etc.) can be developed.

Summary

Relay2 provides enterprise WLAN services with coordinated control between intelligent AP and the cloud. The Relay2 cloud wireless networking solution eliminates the downsides of using hardware controllers to achieve enterprise functinoality - high cost, single point of failure, performance bottlenecks, complex deployment and more. The Relay2 Cloud Service Manager can control thousands of APs across different locations and uses highly secured connections.

The Relay2 Cloud Service Manager lowers the cost and simplifies network management of enterprise class WLAN networks without sacrificing the performance and power of traditional hardware based WLAN controllers.

Beyond just providing robust and manageable eneterprise-grade WiFi, the Relay2 solution enables a broad range of value-added capabilities. Built-in cloud services offer unique capabilites for providing managed WiFI services or creating rich connected experiences over WiFI. Integrated edge compute and storage transform access infrastructure into a highly flexible service delivery platform.

About Relay2

Relay2 helps service providers transform legacy managed services into complete ROI-generating business solutions tailored for SMB and IoT markets. Relay2's pioneering Service-Ready Access Point enables cloud-managed applications and content to be hosted at the network edge, as close as possible to mobile customers, guests, and employees. The open Relay2 platform makes it both simple and affordable to leverage a foundation of high-performance WiFi to build, deploy, and manage innovative edge applications that deliver rich and relevant connected experiences. Relay2 was founded in 2011 and is a privately funded company led by an experienced team of wireless and networking industry veterans.

Corporate Headquarters

1525 McCarthy Blvd.
Milpitas, CA 95035

www.relay2.com
408.380.0031
sales@relay2.com