White Paper

The Economics of Cooperative Control
Protocols are Free

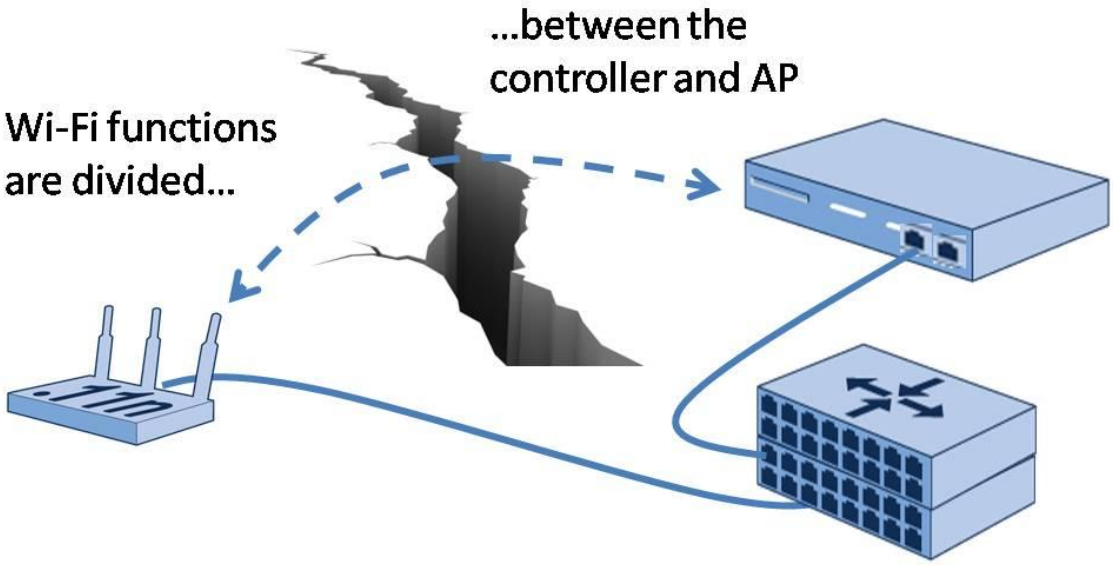
Aerohive Networks, Inc.
3150-C Coronado Avenue
Santa Clara, California 95054
Phone: 408.988.9918
Toll Free: 1.866.918.9918
Fax: 408.492.9918
www.aerohive.com

Table of Contents

Introduction

Today's de facto standard architecture is commonly referred to as the, "controller-based" architecture, sometimes referred to as the "split MAC" architecture. It involves one or more controllers and controller-based (lightweight, thin) APs. The controller-based architecture was created to solve manageability, mobility (as opposed to portability), and high operational expenditure (OPEX) problems that were prevalent in autonomous (fat, thick, standalone) AP implementations.

Figure 1: Controller-based Architecture (controllers & controller-based APs)



While the controller-based architecture solved the manageability and mobility problems, the introduction of controllers created new problems, such as:

- Higher capital expenditures (CAPEX) due to increased hardware and licensing, especially when redundancy is required
- Bandwidth bottlenecks, especially with 802.11n deployments
- Added latency due to traffic u-turns at controllers, especially when filtering at the controller

Creating the controller-based architecture was one divergent path to solve some Wi-Fi problems, but Aerohive went back to the starting point and improved upon the original solution. We call it Cooperative Control. Instead of regurgitating an architecture where costly, centralized management/control platforms are needed, Aerohive followed the original intent of the 802.11 standard designers more closely and brought the technology to maturity. Now inter-AP protocols can execute the same functions performed by centralized controllers, but without:

- The high costs of primary, redundant, and branch controllers
- The high costs of AP and feature licensing on controllers
- The need to re-architect the network to insert a controller
- The central point of failure

- Multiple high-capacity core Ethernet switch ports
- A long learning curve for administrators and engineers
- Traffic bottlenecks and latency
- Layer-2 and Layer-3 Quality of Service (QoS) problems

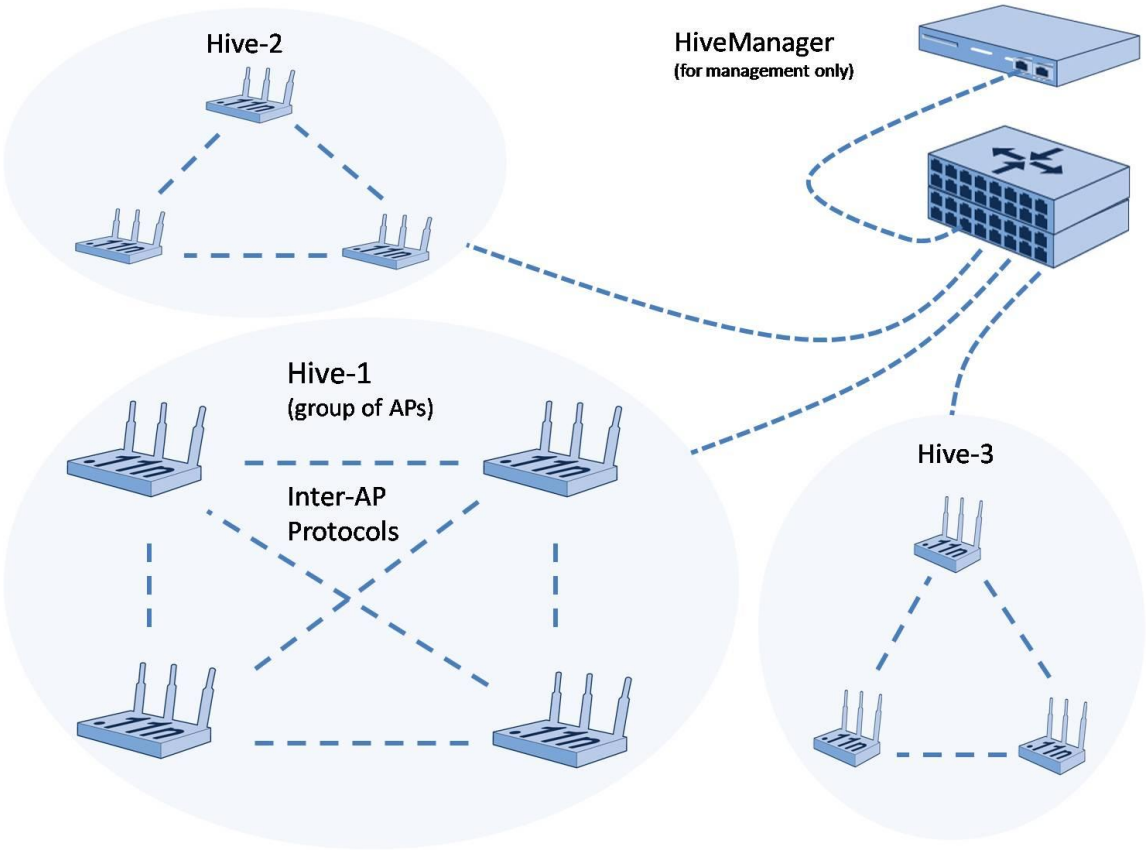
The key takeaway here is that inter-AP protocols are free, but controllers are not. In a market where all enterprise-class APs cost roughly the same, removing the controller hardware and feature licensing from the equation results in an immediate and extremely significant CAPEX decrease. For networks where controller redundancy is required, the savings are simply shocking.

When Ethernet switches run smart switching protocols and routers run smart routing protocols, why should access points be dumb? APs are distributed devices doing distributed computing, and they should run protocols that allow them to coordinate distributed data flow. Aerohive's Cooperative Control protocol suite does the controller's work, which eliminates the need to redesign your network in order to introduce a controller-based overlay infrastructure. That's one less thing to manage, and one less thing to pay for.

Cooperative Control

Aerohive Cooperative Control is a suite of protocols operating between groups of APs called hives. APs within a hive are called HiveAPs. A hive can be as small or large as necessary and is easily customizable to fit branch office, SMB/SME, and/or large enterprise deployments. The Cooperative Control protocols manage functions such as fast/secure Layer-2 and Layer-3 roaming, coordinated RF management, Wi-Fi security, load balancing, mesh networking, and high availability. HiveAPs are centrally configured with a Wireless Network Management System (WNMS) called HiveManager. HiveManager is available as a single instance on a network appliance. Multiple instances or domains can be supported using the Virtual HiveManager (vHM) feature. The vHM feature is usually used to provide separate management domains for multi-BU enterprises, or for managed service offerings or in other hosted environments. Since HiveManager is a management system used for configuration and statistics gathering, it is not essential to the network's ongoing operation. Figure 2 illustrates the fundamental building blocks of Aerohive's Cooperative Control architecture.

Figure 2: Fundamental Building Blocks of Cooperative Control



Economic Deficiencies of a Controller-based WLAN Architecture

When the controller-based architecture was first introduced, the expectation was that the controller-based APs would be significantly less expensive than autonomous APs. If this turned out to be true, it would allow the total cost of the solution to be competitive in spite of the added cost of controllers. Unfortunately, this theory has not been realized in the market. Controller-based APs currently do a significant amount of processing at the AP, and they are made with the same chipsets and components as autonomous APs. As a result of this, their manufacturing costs, and hence their prices, are the same as autonomous APs. Because the controller-based architecture requires that all frames be processed in two locations (the AP and the controller), the architecture requires excessive hardware, even in optimal configurations. The cost of this additional, unnecessary hardware lands sorely in the customer's lap, and when protocols are free, this is a great customer disservice.

Cost Variance

Controller-based deployment costs vary dramatically, depending on 1) the size of the controller, and 2) the degree to which you are able to, or want to, load the controller to its maximum AP capacity. Controller capacities rarely align with the customer's network topology, and as a result, real-world enterprise deployments rarely hit the sweet spot in the controller cost continuum because the enterprise customer ends up buying excess controller capacity.

Redundancy

By design, the controller is the brain of a controller-based network. In many implementations, if the controller fails then all the access points either stop functioning altogether or are reduced to extremely limited capabilities. Thus the recommendation for all mission-critical implementations is for redundant controllers to be deployed. Controller redundancy, whether in a master/local configuration or a clustered configuration, increases network availability but also significantly increases the controller component of the solution cost.

Small Site Deployments

Small sites generally require only a few APs, sometimes only a single AP for pervasive coverage. When adding a controller to this equation, the controller can easily double the cost of hardware alone. When feature licensing is added to the equation, the controller-based architecture can become tremendously more expensive. When an organization has hundreds or perhaps thousands of remote sites, such as a large pharmacy chain, removing controller hardware and licensing costs can easily reduce overall costs to a small fraction of the controller-based model.

Small, independent deployments can take advantage of local AP management offered by Aerohive's HiveUI, which is integrated into 802.11n APs at no extra cost and can manage a hive of up to 12 APs.

Distributed Controllers

Often in high-capacity and mission-critical environments, small controllers are deployed closer to the access layer of the network in an attempt to mitigate performance and control problems caused by backhauling all of the traffic to a centrally-located controller. This reduces the latency and jitter of the Wi-Fi infrastructure by reducing the number of hops that the wireless traffic must traverse to and from the controller. It also means control decisions, like QoS, are moved closer to the network's edge. Reducing latency and jitter while increasing the effectiveness of QoS ensures better network and application performance. While this improves the operation of the controller-based architecture in mission-critical environments, it also requires that a larger number of controllers are purchased, licensed, and deployed. This substantially drives up the cost of controller-based solutions.

The distributed nature of Aerohive's Cooperative Control architecture accomplishes the same tasks at zero additional costs, significantly reducing the cost of a WLAN with these requirements.

Fixed Controller Capacities Force Controller Replacement

As an enterprise adds a new application, such as Voice over Wi-Fi, or migrates to 802.11n access points, the requirement for better performance and capacity increases. It is then likely that the capacity of the original WLAN controller will be exceeded. In this case, additional controllers or larger replacement controllers will be needed. If the enterprise requires redundancy, even more controllers would be required. An example of this would be a branch office or retail location with four APs connected to a controller capable of supporting up to six APs. If the location needs to expand to eight APs to improve RF coverage or to handle the increased number of devices on the network, doing so would

require either a forklift upgrade of the existing small controller to a larger controller, or the deployment of an additional small controller to the site. Add redundancy, feature licenses and the cost of the qualified manpower it takes to deploy a new Wi-Fi infrastructure system and the costs spiral out of control.

Over-purchasing Controller Capacity

Enterprises often purchase larger controllers than they currently need for the purpose of future network expansion. Thereafter, they need only to purchase additional APs when additional coverage or capacity is needed. While this approach is effective from a future-proofing perspective, it has a significant detrimental impact on the CAPEX of the solution. The cost impact of this scenario is especially significant when dealing with large numbers of APs or if this approach is applied to a distributed enterprise with a large number of branch or remote locations. Similarly, if the future network expansion is never performed, the additional up-front cost is wasted.

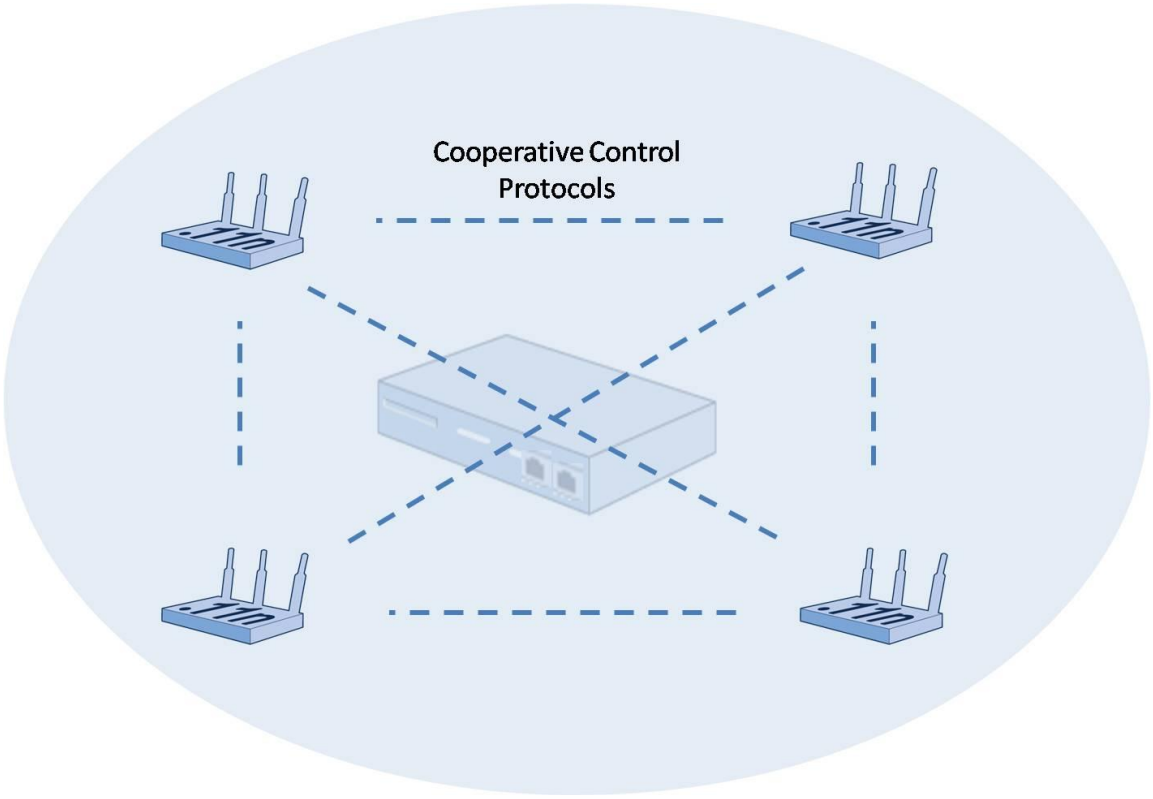
Economic Benefits of a Cooperative Control WLAN Architecture

Aerohive's Cooperative Control (controller-less) approach keeps costs linear and predictable regardless of network size or deployment type, providing the capital cost advantages of autonomous APs and the technical advantages of controller-based approaches. The Cooperative Control architecture also addresses the early OPEX drawbacks of autonomous APs, especially those related to excessive administrative overhead.

Protocols Cost Less Than Controllers

Aerohive's Cooperative Control protocols happen within clusters of APs called hives. Whether you're talking about layer-2/3 roaming, coordinated RF management, security, load balancing, mesh networking, or high availability, the protocols are in there. Figure 3 illustrates the concept of protocols replacing controllers.

Figure 3: Protocols Instead of Controllers



Centralized Management with a Killer GUI and Optional Multiple Domains

Centralized configuration, monitoring, and reporting are provided by Aerohive's state-of-the-art WNMS solution called HiveManager. HiveManager isn't your typical WNMS, and has an amazingly user-friendly GUI interface. Usability is a primary goal, and the GUI is constantly being refined to align with a network administrator's thought processes and workflow. The HiveManager appliance can be located anywhere in the network and is not essential to the network's ongoing operation.

HiveManager is an inexpensive network appliance available in multiple sizes, so that you only pay for what you need. Using the optional Virtual HiveManager (vHM) feature, a single HiveManager appliance can also manage multiple separate wireless LANs or management domains, eliminating the need to deploy separate HiveManagers. This unlicensed feature is especially useful for hosted or managed services where the HiveManager's cost can be amortized across many subsidiaries or customers.

Linear, Predictable, and Scalable Cost Structure

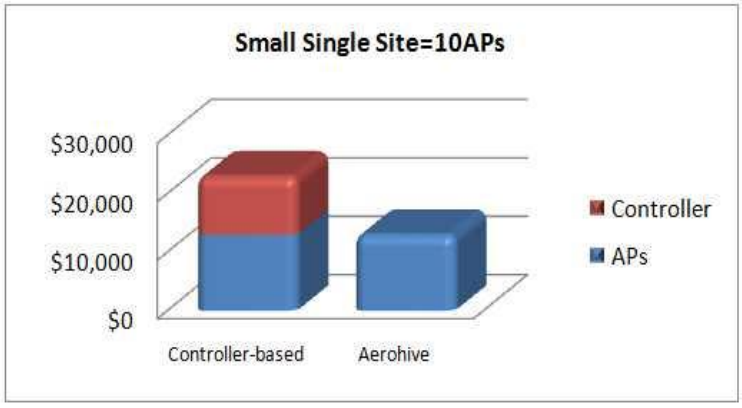
The cost structure of the Cooperative Control architecture ensures linear, predictable, and scalable costs when expanding coverage or adding capacity. Just by adding the appropriate number of HiveAPs, organizations are able to move from a convenience-based WLAN with meeting room coverage to a mission-critical network with pervasive coverage without introducing the stair-stepped, wasteful cost model of controller-based architectures.

And it's not just about coverage. We all understand how important capacity is. With a dual-core CPU, lots of RAM, and dual Gigabit Ethernet ports, HiveAP 300s are, by a significant margin, the fastest APs in the industry. Go ahead. Throw all you've got at them. They won't blink (except for the LEDs). HiveAPs have more power and functionality than the leading controller-based architecture products, and Cooperative Control protocols take controllers out of the equation. At the same price as controller-based APs, the superior ROI and cost model of Aerohive's Cooperative Control architecture is a foregone conclusion.

Inherent High Availability

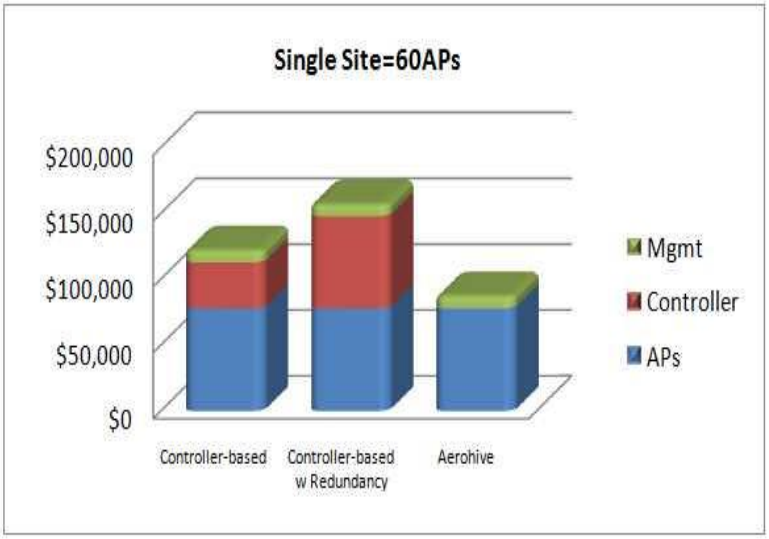
The cost of redundant systems can have a huge impact on the overall WLAN solution cost, especially in large, distributed enterprises with many remote locations. The inherent stateful high availability (HA) and mesh redundancy of the Aerohive approach is superior to even the best clustered controller scenario – without the controller or licensing costs. High availability is achieved using Aerohive's sophisticated wireless mesh, fast/secure roaming, and best path forwarding capabilities. Together, these features allow the architecture to withstand multiple HiveAP outages—and even a wired switch outage—without the loss of WLAN service to the user.

Deployment Examples



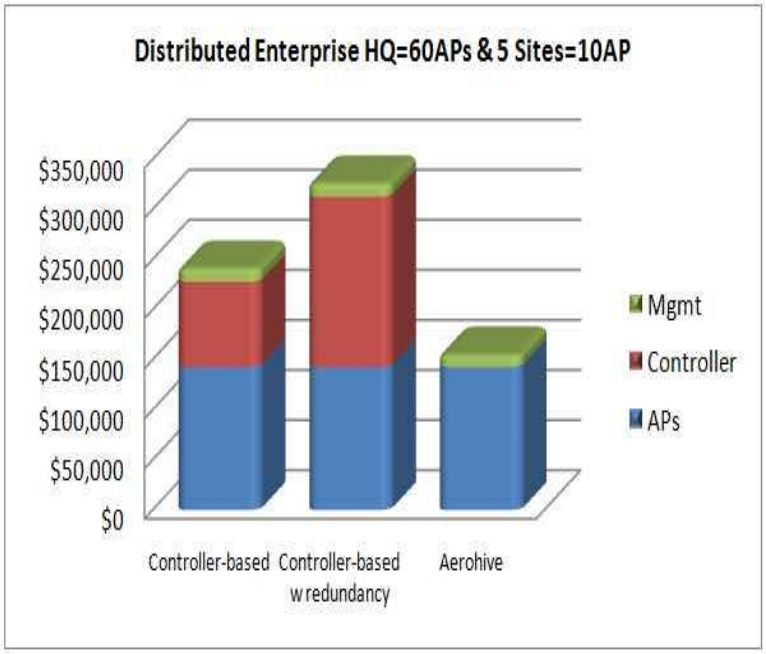
Small, Single-Site Solution

The Controller-based Solution* includes one (1) 12-AP controller and ten (10) 802.11n APs with management provided by the web interface in the controller. Aerohive solution includes ten (10) 802.11n HiveAPs with management provided by the integrated HiveUI web interface, which is able to manage all the APs in the Hive as a system.



Average, Single-Site Solution

The Controller-based Solution* includes one (1) 100-AP controller and sixty (60) 802.11n APs with management provided by a Wireless Network Management System (WNMS). The Redundant Controller-based solution is two (2) 100-AP controllers and sixty (60) 802.11n APs with management provided a Wireless Network Management System (WNMS). The Aerohive solution includes sixty (60) 802.11n HiveAPs with management provided by Aerohive's HiveManager (WNMS).



Distributed Enterprise Solution

The Controller-based Solution* includes one (1) 100-AP controller and sixty (60) 802.11n APs at HQ, and at each of the five (5) remote sites, includes one (1) 12-AP controller and ten (10) APs. Management is provided a Wireless Network Management System (WNMS).

The redundant Controller-based Solution* includes two (2) 100-AP controllers and sixty (60) 802.11n APs at HQ, and at each of the five (5) remote sites, includes one (1)12-AP controller and ten (10) APs. Management is provided a Wireless Network Management System (WNMS). The Aerohive solution includes sixty (60) 802.11n HiveAPs at HQ and ten (10) 802.11n HiveAPs at each of the five (5) remote sites, with management provided by Aerohive's HiveManager (WNMS).

**List price cost comparison with the Controller-based solutions being based on Cisco's 4404 and 4402 Controllers, 1140 series 802.11n APs, and the WCS management system.*

Conclusion

Aerohive Networks' Cooperative Control architecture provides a simple, logical, and low-cost alternative for deploying WLAN infrastructures. The Aerohive approach combines a linear and predictable cost structure - regardless of deployment type or size - with the industry's most user-friendly and scalable WNMS.

Aerohive has created a high-performance, feature-packed WLAN infrastructure system that significantly reduces the overall CAPEX and OPEX costs and the complexity of deploying and scaling convenience-oriented and mission-critical enterprise networks. With Cooperative Control, the intent of Wi-Fi's founding fathers has been realized. Protocols are free.

