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ACCESS POINT ON ACCESS POINT DOCKING AND CONTROL AND PROVISIONING OF WIRELESS ACCESS POINTS (CAP-WAP) TUNNELING

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ABSTRACT
Presented herein are techniques to dynamically dock a new access point (AP) on an existing AP in locations where new association requests may be denied due to load or throughput is below a given threshold. Performance metrics of APs and precise physical location of APs may be obtained from a network management system. Techniques presented herein may significantly improve application user experience in high-density locations such as keynote sessions, sporting events, airport terminals, and/or the like.

DETAILED DESCRIPTION
During operation, increased user density may cause an access point (AP) to share its limited available resources with all connected users, thereby impacting mobility and handoff capabilities. For example, user experience may be negatively impacted in areas/locations in which there may be focused activities and/or in which there may be concentrated browsing trends started by many people. This can lead to intermittent connectivity loss issues and poor user experience. For example, at mega events, games, and/or the like, users may experience attenuated reception.

Adaptive Modulation technologies may have limitations with regard to the effectiveness of a given AP to manage available channels. In general, there is no easy mechanism to quickly add network resources in order to improve end user throughput. Figure 1, below, illustrates example details associated with the impact that increased client density can have on client Quality of Service (QoS).
As illustrated in Figure 1, when the number of users is more than an AP can handle, network QoS and Quality of Experience (QoE) will be impacted.

This proposal provides techniques that may provide for the ability to dynamically dock additional APs to complement already existing APs where network QoS is low. In accordance with these techniques, when an AP is overloaded and user application experience may be massively suffering, a network management system that is monitoring the AP health can determine to allocate additional APs to serve end user load along with the existing AP in order to reduce congestion. The network management system may include maps/mapping logic that can be utilized to provide the precise location of the existing AP experiencing congestion for which user experience may be negatively impacted.

To facilitate the addition of a new AP to help handle the load of the congested AP, a new Aerial Vehicle AP can be guided to the location of the congested AP using precise coordinates provided by the network management system maps. Once the Aerial Vehicle AP reaches the location, the Aerial Vehicle AP may automatically dock itself with the existing AP. In at least one implementation, laser guided technology may be utilized to effectively dock the Aerial Vehicle AP with the existing AP.

Once docked, the Aerial Vehicle AP may acquire power using a Power over Ethernet (PoE) connection and a Control and Provisioning of Wireless Access Points
(CAP-WAP) tunneling process may initiate controller discovery for the Aerial Vehicle AP. Further, once the Aerial Vehicle AP is docked in position, the network management system can configure profile/configuration information for the Aerial Vehicle AP, such as the wireless local area network (WLAN) profile, the Radio Frequency (RF) Profile, the Policy Profile, the Flex Profile, RF TAG, Policy TAG, and Site TAG to the newly provisioned (registered) AP to help the newly registered AP achieve rate and Diversity gain to handle the new load. The newly registered AP can begin serving clients within its range, thereby sharing load with the already existing AP.

In one example, if users move away from the location and throughput requirements for the location fall within the range of the existing AP, the Aerial Vehicle AP can be undocked from the existing AP based on instructions received from a user and/or the network management system. Figures 2 and 3, below, illustrate various example details that may be associated with the techniques of this proposal.

*Figure 2 - Network management system determining AP locations at which user application is low*
Network management system can determine to send buffer APs (drone APs) to a location where user experience is low. The precise location for a buffer AP can be provided by network management system wireless maps.

Backup drone AP will dock itself with existing AP guided by the network management system maps in order to start load sharing with an existing AP.

**Figure 3** - Backup drone AP is flown to a congested location using a location shared by the network management system maps.

Consider an example involving 4x4 Multiple Input and Multiple Output (MIMO) antenna systems. Generally, a 4x4 MIMO antenna system, as illustrated below in Figure 4, can be implemented in order to boost throughput for an AP.

**Figure 4**

In accordance with techniques of this proposal, a fixed 4x4 MIMO antenna configuration may not be needed for a given location; rather, an Aerial Vehicle AP can be added to an existing AP at the given location in order to provide a 4x4 MIMO antenna configuration for the location. In some implementations, a directional antenna may also be utilized to serve a given location.
Unmanned Aerial Vehicle (UAV) technologies are quickly maturing and are used in multiple domains, such as defense, agriculture, emergency response, retail, etc. In many instances, drones can be equipped with advanced instruments, such as high-resolution cameras, gravity sensors, and proximity sensors, etc. Additionally, sophisticated collision avoidance and/or obstacle detection algorithms provide UAV flights that may more reliably reach a precise location. Further, regulations and policies for drones are becoming streamlined. By capitalizing on these advancements, drones can be easily adapted to carry the additional weight of an access point in order to facilitate the Aerial Vehicle APs discussed herein.

There are currently no products in the market that provide for the ability to add new hardware at a precise location on demand. Using advancements in UAV technologies, seamless wireless connectivity can be provided for an increasing number of users and/or applications in accordance with techniques of this proposal.

In some instances, the techniques of this proposal may be useful in locations where the number of users can suddenly spike, such as airport terminals, trade shows, sporting events, etc. at which high quality and reliable wireless services may be needed by users at the locations. By performing analytics on various factors such as load, disassociations, QoS, etc., a controller (e.g., a network management system) can send buffer APs, which may provide an optimal solution since a few APs in a given location can be utilized to dynamically cater to increased loads, as opposed to adding new fixed APs in high density locations.

Various novel features may be realized by techniques of this proposal including, for example, the ability to dynamically add Aerial Vehicle APs at one or more location(s) based on congestions, etc. detected by a network management system. A controller (e.g., the network management system) can precisely navigate UAV APs to a desire location and also direct them back to an initial docking station. Further, these techniques provide for the ability to dock one AP to another AP and share power/bandwidth between the APs.

In summary, techniques of this proposal may provide for the ability to dynamically dock a new AP on an existing AP in locations where new association requests may denied due to load or throughput is below a given threshold. Performance metrics of APs and precise physical location of APs may be obtained from a network management system.
Techniques presented herein may significantly improve application user experience in high-density locations such as keynote sessions, sporting events, airport terminals, and/or the like.