White Paper: Mobile Access Indoor Wireless Solution and Cisco WLANs

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Contents

Introduction

The purpose of the paper is to show that the Mobile Access access pod and the Cisco Aironet access point can share the same Cisco WLAN infrastructure including the CAT-5e/6 cable run while each solution maintains complete functional performance.

Mobile Access is a Cisco Developer Networks partner with Cisco Systems and the MobileAccessVE solution is available through SolutionsPlus. The MobileAccessVE solution cost-effectively provides in building cellular coverage over category 5/6 cables. The solution components primarily consist of the Control Unit (VCU) which is a Head-End element that interfaces with the Service Provider's RF capacity source and Access Pods (VAP) which provide indoor distributed RF cellular coverage. CAT-5e/6 Ethernet cable distributes analog signals from the VCU to the VAP and vice-versa. The VAP radiates the service provider signals at the service providers licensed radio frequency. The MobileAccessVE Element Management System (EMS) which is integrated with the VCU provides remote monitoring and management.

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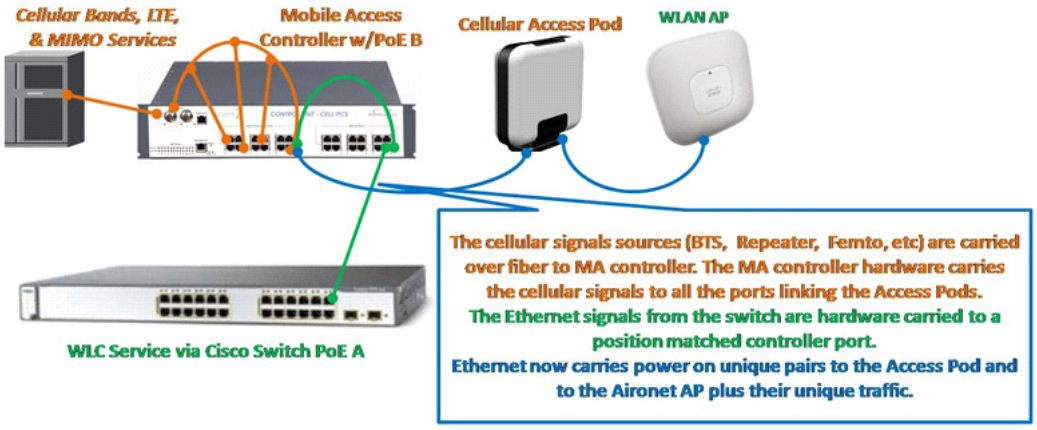
Solution Overview

Mobile Access's solution uses Ethernet CAT-5e/6 cabling to provide in-building cellular signal distribution. The MobileAccessVE solution can reuse the same CAT-5e/6 used by Cisco Aironet Access Points concurrently.

The solution can be configured to operate in any the frequency used by the cellular provider. The Wi-Fi signal is transferred in different frequency bands from the cellular frequencies. They do not interfere with each other when in the air or on wire.

The following picture shows a Cisco switch, an Aironet AP and the MobileAccessVE solution co-existent on the same CAT-5e/6 cable run while simultaneously maintaining full Ethernet capabilities.



Simplified Overview Illustration of the Service Options and Components used in this partnership with Mobile Access and Cisco Systems.

Cabling notes:

- Ethernet LAN packet signals passed over Ethernet cable frequencies between 0 MHz and 125 MHz.
- Cellular signals are converted for transmission over the Ethernet cable to frequencies at 160 MHz and above.
- This configuration allows Ethernet cabling to be passive to cellular and Wi-Fi.
- The separation of the analog cellular signals by the Ethernet cable pairs from the Ethernet LAN traffic signals provides the LAN traffic full bandwidth capabilities.
- PoE is transparent between the two technologies. Even if the MobileAccessVE devices are powered off; the Cisco AP will remain fully functional. Similarly if the ethernet solution is switched off; the MobileAccessVE solution continues to operate.
- The MA Controller pictured above shows that two cellular services(Example Cell and PCS) can be brought into the controller. There are 12 UTP ports than can transport those two cellular services to 12 MA VAPs and those 12 UTP ports are paired to/from 12 Cisco switch ports.

Co-existence of Signaling on the CAT-5e/6 Cable

On the Ethernet port signaling side of the Mobile Access VCU the cellular traffic is transmitted onto the cable at a different frequency than the frequency used for the LAN packets to and from the Aironet AP to prevent interference with each other. The VCU and VAP devices transmit analog radio signals over the CAT-5e/6 cable by down-shifting the cellular frequencies to intermediate frequencies. Since the frequency range used of cellular traffic is different from Ethernet traffic; there is no cross talk or harmonic inference between the two technologies. The cellular frequencies are 140-220 MHz, while the Ethernet spectrum is 0-125 MHz. The MobileAccessVE device performance is not influenced by the presence or absence of Cisco switches or APs. The MobileAccessVE devices that share the same cable run as the Cisco devices are not influenced by the power state(on/off) of the Cisco devices. The MobileAccessVE devices are passive with concern to Ethernet connectivity. The RJ-45 ports on the VCU are strictly pass-through. They are not programmable in the sense of switch ports on a Cisco switch.

Co-existence of PoE on the CAT-5e/6 Cable

The amount of power that a switch provides at the power sourcing port depends on the switch or line card of the switch. It also depends on the model of the switch or line card and the power supplies of the switch. Cisco switches then negotiate the amount of power to provide to the endpoint using the Cisco Discovery Protocol (CDP). A Cisco switch provides power to the Aironet AP. The VCU provides power to the Mobile Access VAP. The ability to provide power to Aironet AP from the CAT-5e/6 cable that is also powering the VAP is done using different wire pairing within the CAT-5e/6 cable for each AP. CAT-5e/6 cable has four pairs of wire. The Cisco switch provides power on pairs 1-2 and 3-6 for the Aironet AP per 802.af type A standards. The MobileAccessVE provides power separately for the VAP on pairs 4-5 and 7-8. Therefore, Aironet AP and the VAP have unique power sources. The MobileAccessVE and VAP pass the power from the Cisco switch through to the AP passively. This separate, independent supply of power on the CAT-5e/6 cables provides the VAP full service functionality and the Aironet AP full 802.11n performance.

Testing to Identify Co-existence Issues

Cisco engineers tested the following items to identify co-existence issues:

- Maximum Ethernet Cable Length
- Ethernet compliance per 802.3 specifications
- Product Safety and Compliance
- Cisco device Interoperability

Maximum Cable Length

The highest length of CAT-5e/6 cable that is recommended for a gigabit Ethernet run is a total of 100 meters. It is recommended that only CAT-5e or better be used in any portion of the run. A run is defined as the total CAT-5e/6 cable connections between the PoE switch port to the final Ethernet client device. All connections to MobileAccessVE Controller (VCU) and the MobileAccessVE Access Pod (VAP) add into that total run length. This is because to the gigabit Ethernet signals, the VCU and VAP are passive, pass-through devices. Therefore, in considering the maximum run length, there will be a minimum of

three CAT-5e/6 cables involved. Cisco ran exhaustive tests with cable lengths well beyond 100 meters to substantiate the 100 meter specification when any devices are connected to the VE system and any medium- to good-quality CAT5e/6 cable is used.

There is no difference in Wi-Fi or Cellular performance whether short or long CAT5e/6 cables are used. Also, gigabit Ethernet performance (throughput, packet error rate) was tested rigorously and no negative effects were observed-the VE system is truly transparent to gigabit Ethernet operation.

Packet error rates were studied with various Ethernet protocols, encryption types, packet sizes and data rates. Packets sizes varied from runt to jumbo. The protocols included TCP, UDP, DHCP, CDP, LWAPP, CAPWAP, EAP-TLS, Cisco LEAP and Cisco VPN. This provided a broad but common list of data protocols, security and authentication protocols and encryption schemes. It certainly is not a complete list but certainly indicates that no type of protocol and encryption incurred a packet error rate higher than another protocol.

Ethernet Compliance per 802.3 specifications

The MobileAccessVE system was examined against 802.3 (Ethernet) physical layer specifications using engineering laboratory equipment. A complete Ethernet compliance test suite was run on the VE system and examined such parameters as constellation error, return loss, and pulse mask. The system exhibits a small amount of parametric degradation, equivalent to the effect of a short length of Ethernet cable about 10-15 meters in length.

Product Safety and Compliance

During the tests, Cisco also verified product safety and regulatory compliance, and inspected the entire set of certifications and test reports associated with the MobileAccessVE system.

Cisco Device Compatibility

Cisco has tested the MobileAccessVE system with the entire portfolio of Aironet Wi-Fi Access Points, and with the CAT3k and CAT4k line of Ethernet switches. PoE functionality per 802.3af/at and compatibility with the Cisco Discovery Protocol (CDP) for enhanced PoE was verified. Note: PoE compatibility could be an issue with legacy EOL'd Cisco access points since those products were designed before the 802.3af PoE standard was ratified.

The system works assuming the 802.3af/at Type A PoE injection convention is used. Any Ethernet client equipment which operates outside of the 802.3af standard or with the Type B methodology may require a special adaptor (supplied by Mobile Access) to reconfigure the PoE to a Type A equivalent. The adaptor solution ensures that customers will be able to deploy the VE system in any current or legacy Ethernet network.

Additional Reference Material

Design Zone for Mobility:
http://www.cisco.com/en/US/netsol/ns820/networking_solutions_program_home.html

PoE information:

http://www.cisco.com/en/US/docs/wireless/technology/poe/technical/reference/Power.html