Deploying IP Multicast Video over 802.11 Wireless Networks

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Background

When deploying an IP multicast video solution over 802.11 wireless networks there are several issues which require consideration.

Wireless networks, by their very nature, are prone to suffer data loss from noise and interference. For unicast transmissions, 802.11 implements layer-2 acknowledgments and error checking to ensure frame delivery. Multicast traffic, on the other hand, has no link-layer error or loss management in the 802.11 standard. A missed or garbled frame is unrecoverable at layer-2; it is up to the application to make sense of the lost data. For H.264 encoded video, this can mean a garbled image until the next whole I-frame (complete picture, provided periodically) is received.

In order to mitigate potential data loss in wireless multicast transmissions, most wireless access points transmit multicast frames using the lowest basic data rate[1] (typically 1 Mbps for 802.11b/g and 6 Mbps for 802.11a).

Since wireless networks are typically multi-purpose, QoS is necessary to ensure that video traffic gets sufficient bandwidth. The 802.11e amendment defines several Quality of Service enhancements for wireless LANs. A subset of these enhancements, known as Wireless MultiMedia Extensions (though commonly referred to as WMM) are found in most enterprise wireless products today.

WMM defines four priority tags for wireless traffic (from highest to lowest):

- Voice
- Video
- Best Effort
- Background

Higher priority traffic is given shorter wait time for channel access. Unfortunately, WMM does not provide for guaranteed throughput or data delivery.

1 Wireless access points can transmit to clients at several different data rates. These rates are decided based upon the quality of the signal and distance from the AP. Basic rates are the set of rates which are required by the access point for any associated clients.

Vendor Solutions

With the growing demand for video over wireless, vendors have been coming out with unique offerings to improve the performance of multicast video delivery over their wireless products.

Most current enterprise wireless solutions consist of centralized controllers managing thin access points. Wireless controllers are able to keep track of which clients have joined multicast groups through IGMP snooping. This allows the controller to forward inbound multicast streams only to those APs with current members of a particular multicast group.

Due to the lack of acknowledgements and error checking for multicast transmissions, many vendors have taken to converting multicast frames to unicast before sending them over the air.

There are two IEEE initiatives expected to bear fruit in 2010 and 2012 to provide some level of network reliability for multicast over wireless.

Providing Video with Unicast in the Last Mile

Assuming it's too early for wireless multicast - particularly for loss-sensitive data like video - the good news is that we can predict with some reliability how much unicast bandwidth we need to provide video of various flavors. In conjunction with Wireless Multimedia Extensions (WMM), the bandwidth can be provided reliably. Aruba and Cisco have radio management and some client steering to distribute the streams. This avoids noise and congestion. Meru lacks radio management, but has the ability to steer clients without re-association.

In addition to the usual bandwidth calculations, based on distance and the RF opaqueness, we have other controls over the level of service:

1. Raise the minimum data rate on the SSID providing video. This effectively cuts out clients that are too far away, and circumvents the situation where high-density video data has to be streamed at slow channel-hogging rates.

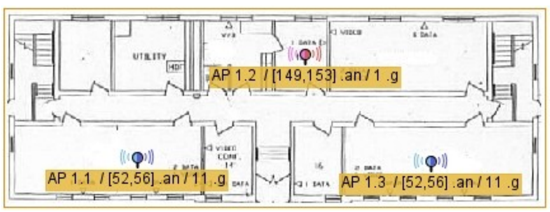
2. In conjunction with the above, pack access points sufficiently close so that the minimum data rate reaches every video client.

3. Segregate video/non-video traffic by band and modulation technique(s). Isolate video traffic to the 5 GHz band. If using 802.11n, configure access points for channel bonding and short guard intervals. If possible, reserve a portion of the 5 GHz band for 802.11n video traffic alone. One could consider separate APs that are part the same infrastructure, but dedicated to serving multimedia in a reserved portion of the 5 GHz range.

Providing wireless IP services for Residences

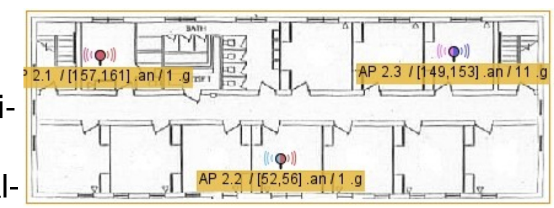
At this time, any 802.11 deployment has to support legacy 802.11 a/b/g clients. And existing deployment may not have support for 802.11n. Whichever the case, AP density has to be sufficient for non-'n' clients. Additionally, if 'n' is available, it will perform best if segregated from a/b/g traffic by apportioning channels for particular uses.

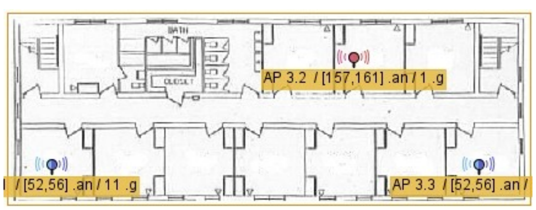
Residence halls in college environments present the most challenging deployment scenario. Students have high bandwidth needs in tightly packed areas. In addition, construction is often cinder block walls and plaster. The first temptation is to light a dormitory floor from the hallway. However, this will result in overlapped footprints and algorithmically reduced radio power; the access points will hear each other better than the residents will hear any of them. The rule of thumb, then, is to avoid traversing more than one solid wall between any access point and dormitory room. Since access points are deployed in 3-space, this may mean that an AP on the floor above or below will be counted on to provide service. Some propagation interference is desirable. 802.11n performs better in the presence of multi-path interference. This means that the coverage in the adjoining room may benefit from the first wall obstruction. Beyond that, the radio signal can be weakened to the point where the signal has to be modulated at slow speeds.



These diagrams depict the basement, 1st and 2nd floors of a residence hall with dense walls. The access points are scattered in 3 dimensions to limit the number of walls or ceilings that need be traversed.

For 802.11n, the available bit rate within one wall-propagation is in the 100+ Mbit range. The number of students served will be approximately 5 per access point. This means that worst case scenario is 20 Mbit/student. In reality, this about twice what should be planned for.





A hypothetical effective 10 Mbit/s is sufficient to support reliable HD unicast 6 Mbit/s video streams for all five students. WMM extensions will protect the bandwidth from other uses. If all students in the dormitory were streaming different video, the terrestrial network would be likely to fail first. Something else to think about in planning: if the same access points are providing a/b/g and n service, the AP may be busy even if the 'n' channel band is not. In some cases—particularly lighter deployments—it makes sense to think about 'n'-only APs

In cases where 802.11a is the modulation technique, a handful of SD streams should be reliably possible, given the techniques cited above: apportion part of the A band for streaming content and increase the minimum bit rate to 12Mbit/S. This, again, is to avoid any client from using the channel at speeds that interfere with higher-rate users.

Conclusions

IPTV can be provided reliably over the air with unicast transmissions.
Vendors' gear typically participates in multicast on the wired side.
WMM, traffic segregation and minimum bit-rates will give a satisfactory video experience.