COMMUNICATING WITH SAM

Wireless LANs:

Optimization Through Convergence

Sam Johnston

Question:

Due to the current economic climate, our company has decided to consolidate offices and warehouses in cities where we previously had separate facilities dedicated to logistics and sales/customer service. Currently we have wireless equipment at both locations. The warehouse locations have 5250 bar code scanners that attach to the AS/400 and input inventory transactions into our order entry database. The office locations that house customer service and sales have wireless telephones that attach to the existing telephone system that permit many of the users to answer the phone either at their desk using a wired handset, or alternatively any where in the building via the wireless set. Both of these applications have been in place for over five years, and we have realized significant productivity gains by making our staff mobile and flexible in how they work within the building. Management expects the office consolidation to result in reduced real estate costs, but they are also anxious to generate productivity gains to improve the business case.

Given the track record of previously introduced wireless applications, expanded use of wireless technology is key to the relocation plan. Specifically, in addition to maintaining the existing bar code scanning application in the warehouse portion of the facility, they would like to ensure universal coverage of the facility for wireless telephones to ensure that all existing users can roam to all departments without losing connectivity. Further they would also like to expand the wireless telephone network to include users on the logistics side of the business, as well as add the capability for laptop users to roam the facility while staying connected to the network.

As we have a large number of wireless access points between the two locations, we are hoping to combine this equipment at the new facility to create a larger network to cover the entire facility for all applications. Will we have any issues in doing this, and can you make some recommendations on how we can successfully achieve our goal?

Answer:

It has been about a year since we have dealt with wireless LAN applications. The good news is that since this time the network infrastructure, or wireless Ethernet access points as they are known, have remained a constant, with the cost of the technology falling and the functionality increasing, which is indicative of maturity. Over this time the voice technology capable of leveraging wireless Ethernet technology has grown exponentially, leading to wireless LANs being a significant place for the early adoption convergence. The bad news is that not much has changed in a year in terms of leveraging wireless investments of the vintage that is applicable to your environment.

These investments are legacy products that lack the flexibility to scale and have limited ability to integrate with current technology.

To make sense of the issue, we need to start with an understanding of how your existing technology works relative to existing standards. The wireless LAN technology that is generally deployed in enterprise networks is typically unlicensed RF (Radio Frequency) spectrum technology. This technology uses the ISM (Industrial, Scientific, Medical equipment) RF Band, managed by Industry Canada, which deploys Spread Spectrum Technology. These frequency ranges are not licensed by the CRTC, which makes it easy for a company to build and control a private network.

However, as no one is restricted from using this technology, you can get interference from networks built by others, especially when deploying the technology for outdoor coverage.

There are two types of Spread Spectrum technologies. The first, Direct Sequence Spread Spectrum (DSSS), multiplies a signal by a direct sequence which results in the signal spreading over a wider bandwidth, meaning that less signal is required to obtain greater throughput over a short distance. Alternatively, there is Frequency Hopping Spread Spectrum (FHSS), where a transmit frequency hops according to a pattern known to both the transmitter and the receiver. Without getting into vast amounts of technical detail, the key thing to note between the two technologies is that although FHSS

provides additional precision in certain situations, it is much easier to obtain higher speeds via DSSS, and as such DSSS has become the market preference. Initially the manufacturers that dominated this technology were niche players specializing in wireless technology only. Although some such as Wi-LAN do still exist, the major players are now major enterprise networking suppliers such as Cisco, Avaya (formerly Lucent) and 3Com. Their interest in the segment has coincided with standards development and the prevalence of DSSS.

The other technical evolution that will impact the investment protection of your existing investment is the frequency range changes that have taken place. Initially unlicensed Spread Spectrum technology used the 900 MHz frequency range, which was the basis for early adoption applications such as RF bar code scanning and telephones, also known as PTCs (Portable Transaction Computer). The current standard is 2.4GHz, also known as 802.11B.

The 2.4Ghz technology has been in existence for about six years, but has only moved to the forefront over the past two or three years due to the emergence of wireless LANs to support PCs, which required more bandwidth relative to early uses. The higher the frequency, the larger the Fresnel, or wave size, which delivers more bandwidth. A 2.4Ghz radio can provide up to 11Mbps, although as the device moves to the edge of the cell covered by the radio this will fall to as low as 1Mbps. If you need to guarantee high bandwidth, then you need to reduce cell sizes to ensure that the edge can deliver the necessary bandwidth.

A new 802.11A standard is emerging at 5.2Ghz that will deliver up to 54Mbps. As noted above, the trade-off of increased throughput is that range of each radio is reduced. This has design implications if you are migrating from say 900Mhz to 2.4Ghz, or now 2.4Ghz to 5.2GHz and need to optimize the throughput of the radio. The reduced range means you will need a higher density of access points to take advantage of the bandwidth capabilities, so don't make the mistake of thinking you can merely replace existing 900Mhz locations with a new 2.4Ghz radio, 2.4Ghz with 5.2Ghz radios, and realize bandwidth gains. To fully realize the gains you will need to reduce the cell sizes, which means a re-design of your cell layout.

As is usually the case with any emerging network technology, the early adoption applications generally rely upon application specific networks, and wireless was no different. Generally speaking 900Mhz technology also relies upon proprietary communication protocols for the device to attach to the host system, unlike 2.4Ghz technology which is Ethernet, IP and open standards based. For example, assuming your wireless PTCs are 900Mhz technology, they likely need to connect to a single purpose access point specific to those scanners, while connectivity to the AS/400 likely requires a specific wireless IOP card. Assuming your phones are 900Mhz, you are likely dealing with two issues. First, legacy PBXs are highly

proprietary, and thus both the wired and wireless phones likely are specific and proprietary to that PBX. Secondly, to make matters worse, typically the access points are also proprietary and specific to the wireless phones for that PBX. Although the communication protocol may be proprietary and specific to each brand of access point, eliminating the ability to use a single access point for both your voice and scanning applications, they both use the 900Mhz frequency range. Thus if you need to cover the same area with both wireless scanners and phones, there is a risk that the two application specific networks will interfere with one another through frequency overlaps created by multiple radios in a cell area using the same channel. Although this can be overcome via channel design by eliminating duplicate channels in the cell and adjacent cells, the small number of channels available makes this difficult even in a single network scenario. We'll discuss this a little later when we come to design recommendations.

Based on this background, the potential for you to combine the two existing wireless networks into one larger network at the new facility faces challenges, and co-existence may also be out of the question. The probability is low that both types of access points will each be capable of supporting both the phones and the PTCs. Although it may be possible to purchase additional access points of each type to enable the building of two application specific networks with complete coverage of the facility, this is not recommended. It is unlikely that the network will be small enough to manage frequency overlaps from duplicate channels, and it is probable that you will go through this effort and neither application will work. Further, many of the 900Mhz access points used for RF scanners have been pulled from the market, making acquisition of additional hardware and support a challenge. Even if you were to successfully build two co-existing RF networks using the existing equipment with additions, you would still be faced with the fact that only 2.4Ghz cards are available for PCs, and they are not compatible with 900Mhz radios. If you want to move the existing equipment to the new facility, the likely best case scenario is that you would be able to build two separate networks that do not overlap. The existing wireless telephone network would be transplanted to the portion of the facility for customer service. Locating the existing RF scanner network in the warehouse portion would result in a second network. In this case you will still need to be careful of frequency overlap where the edge of the two networks meet, and of course you will not be able to extend wireless phone use to the warehouse area. To obtain laptop coverage, you could build a third network based on the 2.4Ghz standard, which would not conflict with the legacy networks as it operates on a separate frequency, but it would make things very complex to manage.

Setting cost parameters aside, the ideal option is to build a single, net new 2.4Ghz wireless network that is application independent to cover the entire facility. The complexity in this scenario is that your existing wireless devices likely have little value. When the industry was in the early stages it was not standards driven, and as such 900Mhz cards cannot connect to 2.4Ghz radios, leaving little investment protection for devices that can only accept a 900Mhz card. The phones that represent the bulk 900Mhz market place typically have no capability of migrating from 900Mhz to 2.4Ghz, while most of the PTCs prevalent in the AS/400 community do have a migration path. Generally most PTCs can convert from 900Mhz to 2.4Ghz by simply changing to an 802.11B card and firmware upgrades. However, this is not always the case, and even if it is, often the cost of converting is close to the price of purchasing a net new 2.4Ghz device, so you will need to review this issue in some detail. The other area to review is AS/400 connectivity. Early deployments of PTCs relied upon a dedicated wireless IOP, feature code 2668. This feature can be a limiting factor in upgrading your AS/400. When we last reviewed this feature, it was only supported on 6XX or 7XX upgrades to an 8XX

footprint. Hence to preserve your wireless infrastructure you may face a rather stiff premium on theAS/400 upgrade, which is one more benefit of implementing the 2.4Ghz technology which would permit AS/400 connectivity of PTCs via the Ethernet interface. Legacy PTCs, when converted to 2.4Ghz, become 802.11B devices, meaning that any 802.11B access point can deliver connectivity.

A question that often comes up is the impact of the emerging 5.2Ghz standard. Many of our clients are asking if they will face similar issues associated with migrating from 900Mhz to 2.4Ghz, and whether they should delay deployments until it is in the market place? Fortunately the market is now dominated by networking companies who understand the need to provide smooth technology migration paths. Based on early information, it would appear that manufacturers will be launching 5.2Ghz access points that will be backwards compatible with both 2.4Ghz access points and cards. This means customers can upgrade segments of their network as more bandwidth is needed while maintaining existing investments, similar to migrating from 10 to 100Mbps in a switched world.

The 2.4Ghz telephony world provides some interesting options. With the adoption of 802.11B as a standard, openness has become prevalent, with the phones looking more like PCs than handsets. Should you implement a 2.4Ghz wireless network, you are no longer forced to adopt proprietary phones that only work with a specific brand of PBX. Companies such as Spectralink, the leader in this technology, have developed devices that use IP to access the wireless network and provide integration to all of the leading PBX brands that are currently in the market. This includes both legacy, or traditional, PBXs, and new emerging IP-based call processors. There are a lot of parallels to the early stages of PC networks in the AS/400 world, where the IP-based PC network could connect to the AS/400 either via an SNA gateway for translating or by enabling IP on the AS/400. In the wireless telephony world, the phone connects to the wireless network using IP, and is transported over the network to the PBX or call processor using IP. If the call processor is IP based, it simply connects to the call processor via the Ethernet LAN using IP. If it is a legacy PBX that has not been IP-enabled, which is an option on many PBX models, then a gateway is required to translate the phone from IP to the proprietary protocol specific to that PBX. Regardless of which deployment you select, a single 802.11B 2.4Ghz access point network can support telephony and all data applications, ridding you of an application specific network.

Although the technology is generally open standards, there are some decisions that have long-term limitations. For example, Spectralink phones that can connect via a gateway to a legacy PBX cannot migrate to a pure IP-based solution, despite both using IP at the network transport layer. Often in telephony the cost prohibitive factor that limits the changing of solutions is the handset investment. Consequently, before making the decision on which model is best for you, you need to consider the future of the current PBX and whether IP telephony is a strategy in the cards for your organization. Even if the PBX is staying in the near term, you could chose a pure IP solution, deploying an IP call processor to handle the wireless calls only, and in place of the gateway, integrate the IP call processor to the legacy PBX. This maintains flexibility for the long-term by adopting IP in new investments, and is similar to how we migrated from SNA to IP from an AS.400 perspective.

With the emergence of technologies such as XML, wireless IP phones are beginning to look like PDAs, and in the future it may be that the wireless phone can replace other data devices. Given these profound changes, vision will be important. None of the options are cheap, so know your decision criteria before you make the final recommendation to management.

If you do decide to migrate to the 2.4Ghz wireless standard and implement IP wireless phones, you need to pay careful attention to the planning and design of the network, in particular if applications are going to share the network.

Some of the key things to consider in planning the network are as follows:

Focus on understanding network coverage and cell layout:

2.4Ghz access points have 11 channels, and to avoid frequency overlaps, access points adjacent to one another require a minimum of two channels of separation. For example, a cluster of four access points that have cells that overlap one another would have to use channels 1, 4, 7 and 11. Given that there are only 11 channels, adding more adjacent access points with cell overlaps for coverage can become a challenge. Spend the time to layout the cells correctly to ensure that you do not encounter issues in the deployment phase. When doing the cell layout for a multi-floor facility, remember that signals can transmit through floors and ceilings, so the channel layout needs to account for horizontal and vertical adjacencies.

Provision enough bandwidth to service your concurrent voice users:

When sizing the bandwidth needs of the wireless network, you should note that a wireless IP call requires 150kbps of bandwidth for each concurrent user, unlike wired IP calls which when using G729a compression only require 11kbps. This will impact cell design in areas where there is the potential for a large number of concurrent users. As noted previously, as you reach the edge of a cell, signal strength reduces the throughput available. In the case of 802.11B technology, when the cell size is not restricted the throughput reduces from 11Mbps at the point closest to the access point, down to 1Mbps at the edge. In provisioning, you must assume the worst case scenario, and that all users could be at the edge. If the cell size is unrestricted, the maximum number of calls possible on the access point is six, for a total of 900kbps, leaving 100kbps for other applications. If you have an area where there could be 25 concurrent users, you will need a minimum of 4Mbps at the edge of the cell. To assure this, you

would need to adjust the radio to restrict the cell size at the point where signal strength would drop below this level. This will increase access point density levels, which will put increased pressure on channel design.

Make sure voice quality is protected via QoS:

Voice communications in the wired world is adversely impacted by network contention issues such as latency and jitter, and in an IP telephony world the contention nature of Ethernet can be problematic without the deployment of QoS (Quality of Service). The wireless Ethernet world is no different, and QoS is a crucial component. You will need to make sure that the wireless phones support QoS, and more importantly the networking infrastructure. The QoS will place priority on the maximum number of concurrent calls assigned to each access point, which will be six if the cell is unrestricted and is at 1Mbps at the edge. In theory this leaves only 100kbps for data users if the maximum number of concurrent voice users is reached, however, in practice it will be more. Your cells will overlap, and devices will attach to the access point with the best signal when in the overlap zones, so in practice, the bandwidth for the call is guaranteed, and the overlap will create an over-provisioning effect. However, you cannot rely on the overlap to deliver QoS to voice applications that need guarantees. Remember that QoS needs to be provisioned end-to-end, so not only should the access points support QoS, but also the LAN backbone that they connect to.

Other design considerations that will impact your rollout are numerous and beyond scope of today. However, the best advice is that don't let the relatively simple installation process for an access point fool you into thinking that the technology is simple. The technology is complex, and cutting corners in planning will only lead to grief. In the end, the good news is that your organization understands the value of wireless applications, and has had positive experiences in driving productivity gains. Unfortunately, as an early adopter of the technology, your initial investments have likely run their course and to move the bar to the next level you will need to go through a period of re-investment. Fortunately for you, your organization has a track record in achieving productivity gains with wireless applications, which should provide you with the financial matrix necessary to determine the ROI associated with the new investments.

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***Sam Johnston** is a partner and Chief Technology Officer of Intesys Network Communications Ltd., providing value-added networking and e-commerce solutions to theAS/400 community. He can be reached at (416) 438-0002 or via e-mail at sjohnston@intesys-ncl.com.* *Any TUG member wishing to submit a question to Sam can forward their typewritten material to the TUG office, or to Intesys. The deadline for our next issue is Friday December 7th, 2001.*