Effective Solutions for Wireless Carriers'

In-building Challenges

Abstract: With nearly ubiquitous wireless coverage in outdoor areas, service providers are focusing on in-building coverage gaps, especially where there are concentrations of high-value business customers. Yet due to technological, economic and building owner challenges, uniform delivery of a quality signal to subscribers inside large buildings and high-traffic public facilities has been an elusive goal. New solutions involving multi-carrier, protocol-agnostic systems, combined with leased-infrastructure pricing, open the doors for wireless service providers to capitalize on this fertile opportunity.

Introduction:

According to a recent IDC report, 41.6% of wireless users reported using their wireless phones at work, a 58.8% increase since 1999. Additionally, subscriber base and traffic volume are projected to expand as users view wireless communications less as a luxury and more as a necessity for their safety and convenience. Increasing numbers of business users now view mobile phones as their primary personal communications device, driven by:

- A decline in wireless pricing
- An increase in service plan minutes
- Improved geographic coverage
- An increased emphasis on "personal" communications and service. "I want to call the *person*, not the place." An estimated 10% of wireless calls roll to voice mail as compared to 40% of wireline calls.
- A more multi-tasked, mobile workforce spending 60% or more of their time away from their desk or office

As service providers look to enhance existing voice services and launch new data applications, uniform wireless coverage within large buildings and ongoing customer satisfaction are a critical factors in future revenues. Overlooking this opportunity could mean customer diversion to alternative technologies and service providers, which translates to missed revenue opportunities.

The In-Building Coverage Gap:

The core challenges that have historically faced wireless carriers in providing effective in-building services are technical. Wireless network design generally requires high frequency reuse, which can erode signal quality above the 7^{th} floor in most buildings. Within a given space, a wireless signal will range from high quality to sporadic to none at all.

While building materials sometimes cause insufficient signal strength, there is another issue that arises in high-rise buildings. Received signal strength indication (RSSI) on upper floors where problems are reported often tests sufficient. This can be misleading, however. The sufficiency of the RSSI is often due to a composite of many signals from many different cell sites.

As height above the ground increases, the subscriber passes into the upper suppressed portion of the closest cell site antenna. The signal strength then becomes comparable to more distant cell sites, though above signal to noise ratio (SNR). The lack of terrain blockage and the height above the ground eliminate the isolation the subscriber would normally enjoy from composite network interference and signal degradation is the result.

Dropped calls and "dead spots" in buildings are common problems for in-building wireless users. This yields the perception that wireless "can't be trusted." As a result, users tend to dismiss wireless communications and depend on the traditional wireline services. The wireless services provider loses minutes of use and thus revenue, decreasing customer satisfaction. According to IDC, subscribers want "quality of service with a clear received signal from anywhere on the premises." This means an acceptable signal over 95% of the covered area. In a study by the Yankee Group, coverage and reliability were critical to creating wireless customer loyalty.

Challenges

A plethora of in-building solutions have been introduced in the marketplace, mostly from wireless infrastructure equipment manufacturers. Unfortunately, providing equipment and technology addresses only one aspect of the in-building coverage challenge. These available solutions, to a certain extent, contributed to the hesitation in wireless service providers, building owners and tenants to fully embrace the in-building wireless opportunity. A more complete view of the of the solution addresses all elements of in-building coverage, including technology, real estate relationships and capital requirements.

Technology Challenges

Technology challenges have primarily centered on interference, based on two common solution scenarios. In the first, electronics were distributed throughout the area targeted for service delivery. These electronics were designed and implemented to successfully deliver the services of the installing provider. When tested in isolation, the system worked well. However, in virtually every major market, there can be up to seven service providers operating in close proximity. When called upon to function in the presence of a service provider operating perhaps next door, interference of one sort or another occurred. In some cases, interference was so bad that receiver overload occurred and the in-building system stopped functioning.

In the second type, the electronics installed in the building functioned well for the installing service provider and also withstood compatibility issues with other service

providers' equipment. Problems arose because the equipment had not been designed for interaction between the in-building system and the macro network of the installing provider. In the case of one national carrier, the in-building system had to be disabled by the switching network whenever the external network experienced high traffic loads so full external network capacity could be used.

Real Estate Access Challenges

For wireless service providers, the cycle time to gain access to a building for deploying in-building coverage systems can be long. Coordination with building owners and construction crews represent a significant investment in time and project management resources. Building owners want to accommodate tenants with quality wireless coverage, but are wary of tenant disruption during system installation and ongoing operational issues such as maintenance, repairs and upgrade.

In addition, installed systems are usually tenant-specific. If a tenant moves out, the equipment becomes a liability to the building owner rather than an asset. The service provider may come back to retrieve the equipment, causing possible disruption to other tenants. Or, in some cases, the system components may be abandoned in place, causing obstruction to future installation. Overcoming a building owner's objections, easing their concerns from a tenant perspective and establishing an ongoing relationship are all critical in gaining agreement to deploy in-building coverage solutions.

Economic Issues

From a single-service-provider perspective, in-building coverage solutions have traditionally presented an economic vs. customer service dilemma. Available solutions approached the in-building problem from a distributed design perspective. The deployment of RF electronics is dispersed, keeping antennas and active elements close to the users. This increases the possibility of providing the necessary ubiquitous service and circumvents various obstructions in the building such as walls, metal supports and other partitioning. Dispersed electronics tend to be more expensive, however. If a small unit were installed on each of six floors, the configuration would require six power supplies…or battery backup systems…or whatever the required equipment, adding to costs for acquisition, provisioning, operation and maintenance. With a six-floor configuration, a technician would have to visit six locations to upgrade the system.

Many past in-building wireless solutions have been installed using the distributed approach for workability over economics. Besides the higher upfront make-ready and capital costs, significant expenses are required for monitoring and maintenance – up to 10% of acquisition cost per year. As a result, the economics have often become unfavorable, and it has been increasingly difficult for a single wireless provider to justify the investment. The economic issue is further compounded in multi-tenant buildings where the tenant base changes frequently, in an industry where customer loyalty to a single provider tends to be low.

The economics of in-building coverage is favorable toward a consolidated design approach where all electronic components are placed in one physical location and powered by a single power supply. Signal distribution is propagated via passive elements throughout the building. Only one backup power system is required. Upgrades are simpler and less expensive because a technician visits one location instead of several. Consolidating electronics and minimizing active components in the tenant space also means lower ongoing cost to operate, maintain, provision and upgrade. This design approach is also more attractive to a building owner due to less tenant disruption because the issue of building access for operation, upgrade and maintenance are tremendously simplified.

The InnerWireless Solution:

InnerWireless provides a complete solution for in-building coverage to wireless service providers that addresses the three major challenges: technology, real-estate access and economics. Considered a "neutral host provider" by some industry analysts, InnerWireless designs, deploys and finances shared wireless infrastructure in buildings for service providers.

InnerWireless's solution - a combination of proven technology, design and deployment expertise, real-estate relationships and financing flexibility - is designed to overcome the constraints that have stood in the way of successfully capturing the in-building opportunity. Providing a neutral infrastructure that can serve multiple carriers independent of protocol greatly increases the economic feasibility of in-building wireless services. Our in-building solutions are capable of simultaneously transporting licensed and unlicensed frequencies between 400 MHz and 2.5 GHz using any air interface including AMPS, CDMA, TDMA, GSM, GPRS, Edge, IDEN, 3G, 802.11b, etc.

InnerWireless is a solution provider. We manufacture certain equipment items, but we do not manufacture where there is an existing item that fully serves the functional purpose. We operate collaboratively rather than competitively with equipment manufacturers. We also operate cooperatively with carriers because we have no stake in subscriber business.

Consolidated Electronics/Dispersed Delivery

To overcome the conflict inherent in the economic advantages of consolidated electronics versus the effectiveness of dispersed RF electronics, InnerWireless has engineered a solution that combines the advantages of both.

For economy, we collaborate with existing vendors to provide a consolidated base station. For effective distribution, we carefully engineer a combination of antennas combined with "radiating coax" to uniformly distribute the signal throughout the building. This combination effectively abides by the first rule in RF installation: to always keep the end user close to an antenna. It also circumvents the three major

interference issues: building structure, other signals in the area and interaction with the macro network.

Careful engineering in consideration of building material, window material, elevator spaces and office partitions overcome building structure issues. Interference and issues of interaction with the macro network are overcome by keeping the distribution system close to the subscriber. Lower transmit power levels are required to deliver a reliable signal in relation to area interference. At lower signal levels, the likelihood of interference with the macro network is reduced because the signal stays within the building structure's isolation capability.

An added benefit to this type of delivery is that using lower signal levels increases network capacity. When the signal stays within the building's isolation capacity, the same set of frequencies can be reused for all buildings.

Long Lifetime

This type of hybrid consolidated/distributed system is much more attractive to a building owner than fully distributed electronics. Most of the system is free from obsolescence and repair concerns. Typically, the centralized base station electronics are the single point for upgrade, maintenance and operation. Since the combination "leaky coax" and antenna distribution system has no active electronics, its lifetime is consistent with the lifetime of the building. Once installed, it is there for 20 or 30 years with little or no maintenance.

In a distributed environment such as this, a high-rise building might require repeater/regenerators every 15-20 floors. This is still a tremendous advantage over a strictly distributed system because in a 60-story building, such a system could contain 60-240 elements requiring maintenance, upgrade and operation. InnerWireless' solutions would require perhaps 5-6 active elements.

Conclusion:

The in-building wireless opportunity is one that promises great potential for wireless carriers. In fact, it may be critical to future revenue growth in the wireless sector. The challenges to capitalizing on this opportunity have involved technological issues, building owner issues and the economics of available solutions. The key to the success of in-building wireless systems lies in providing ubiquitous, reliable service to the subscriber.

The InnerWireless solution provides a protocol-agnostic in-building distribution system that can be shared by multiple carriers. Careful engineering and a unique ability to combine the advantages of consolidated electronics with dispersed delivery solve a number of persistent challenges carriers have experienced to delivering reliable in-building wireless service.