Software for In-Building Network Design

Networks are complicated, particularly for wireless; predictive tools help

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In-building networks have become nearly universal. Commercial buildings and homes need structured cabling or other wired or wireless management systems to connect to networks outside the building. Engineers and designers must plan networks for energy systems, alarms, surveillance cameras and LAN cabling.

Fiber-to-the-home vendors need planning tools to design home and street fiber distribution for broadband TV, phone and Internet access. Fortunately, they can adopt tools that in-building wireless operators and integrators are already using. They can use wireless for the "first meter," too; bandwidths and quality of service for the emerging new class of "11n" routers are high enough to transmit HDTV within a dwelling unit.

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We're not talking only of WiFi when we consider wireless, either. Cellular providers are looking harder at putting cell sites or signal boosters inside buildings, as their data-rate needs increase.

This wireless industry example serves as a case study to demonstrate how in-building network design just got easier.

Beyond Prediction

For many years, designers of in-building wireless networks used outcome-prediction tools, not because these tools were well suited for the job, but because they were all that was available. Designers then tested their networks by installing them and turning on the switch. If the system worked, even if not optimally, the designers called their work a success. A single planning error could result in a costly re-installation and delayed service.

As the stakes got higher, these seat-of-the-pants methods became riskier. Property owners who wanted to keep their tenants satisfied couldn't afford to rely on subjective engineering judgments. Neither could wireless operators, who spent millions of dollars on new technology rollouts. Unoptimized designs put stress on typical WiFi and other mature networks with dense frequency reuse (see article by Tom Henderson in this issue). On the newest WiFi and other wireless networks, where interference must be kept to a minimum, poor design affects quality of service as well as bandwidth.

To build the multi-band, multi-operator and multi-technology networks that are needed today, we must look beyond prediction tools to find solutions that can handle multiple technologies in a common architecture.

The Value of Standards

Can you imagine an Internet world without MP3 or PDF? Before these standards were adopted, we listened to music and exchanged documents – with difficulty. The standards added convenience and suddenly made document sharing much easier. Standards bring the same benefits to in-building wireless network design. By using a standard file format to create a design, we can share project documentation across the entire value chain, from the engineer who designs the network to the equipment installer and even the property owner.

Today, wireless users are demanding ever-higher levels of service, and networks are becoming increasingly more complex. The reasons for this include:

- Data-centric, smart wireless devices
- Data-heavy 3G wireless applications
- Design methods like radio-over-fiber distributed antenna systems
- New in-building technologies such as Wideband Code-Division Multiple-Access (WCDMA), High-Speed Downlink Packet Access (HSDPA) and 1x Evolution, Data-Optimized (1xEV-DO).

Because 70 to 75 percent of 3G (data) traffic originates within buildings, the quality of mobile signal coverage inside buildings is what determines the effectiveness of 3G mobile applications.

Whether an in-building design is active or passive, the goal is seamless coverage. Over a building's life, effective use of bandwidth through better engineering means reduced costs for construction, commissioning and operations.

The Property Owner Perspective

Finding a new tenant costs ten times

Technologies	HSDPA, 1xEV-DO, Wi-Fi, Wi-Max, CDMA, WCDMA, EDGE, GSM, GPRS, iDEN, TDMA, AMPS…
Frequency Bands	VHF, UHF, TETRA, 450 MHz, SMR800/900, Cellular850, GSM900, Paging, DCS1800, PCS1900, UMTS2100
Signal Distributions	Passive, Active, Fiber Optic, CAT-5/6, Hybrid

Table 1. In-building design has become increasingly complex.

as much as renewing a lease. That's why property owners who want to improve return on investment (ROI) must keep their tenants happy. And the best way to keep tenants happy is to provide excellent broadband service. According to a recent Realcomm Advisory Wireless Overview, "Commercial properties retain key clients with in-building wireless coverage and there are numerous cases of office tenants who are including wireless coverage as part of their lease negotiations. Owners are taking notice of this growing trend."

When they retrofit an existing building, property owners need to install wireless networks with as little disruption and complexity as possible. A key requirement is having only one system to wire. The ideal wireless network is one that can distribute signals from multiple operators and multiple technologies, on multiple bands, over multiple media like coax, fiber and CAT-5/6.

Today's In-Building Design Challenges

In the early design stages of an in-building wireless project, RF engineers often piece together spreadsheets, word-processing documents and CAD drawings to create complete network designs.

Imagine having to use these tools to design a network supporting the technologies, frequency bands and signal distributions shown in Table 1.

Even for the best engineers, transferring data between applications while managing all these layers of technology and performing complex calculations invites errors. And prediction software, used alone, can bring more uncertainty to in-building projects.

Prediction software is only as good as the numbers put into it. If estimates of building losses due to features such as walls, cubicles and windows are off even slightly, predictions will be incorrect and modifications will have to be made during network installation. Since installation accounts for half the cost of each in-building wireless project, accuracy is critical.

For Cell Phones

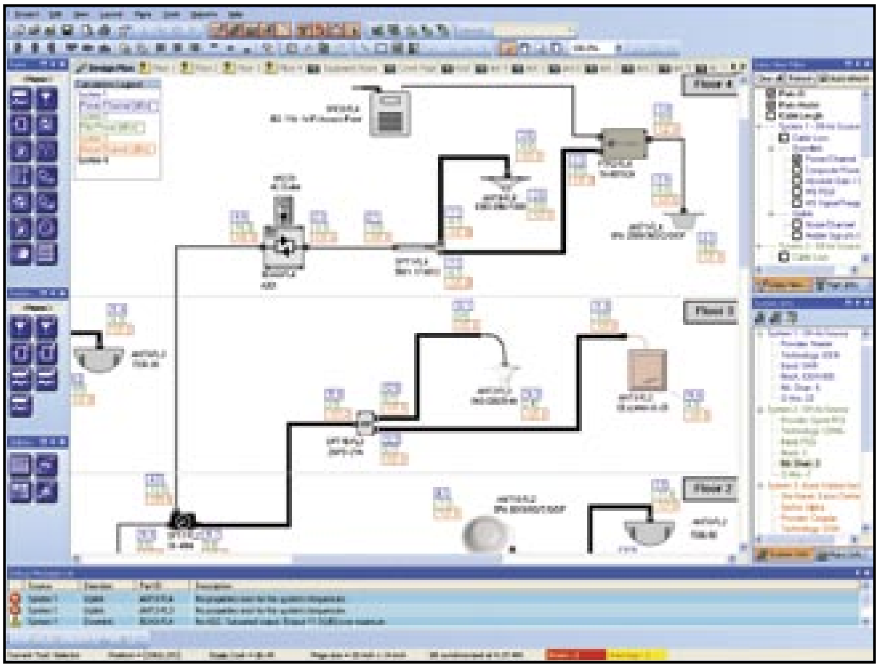
As new technologies such as WCDMA, HSDPA and 1xEV-DO are introduced, operators and property owners must work together more closely. These technologies are all based on Code-Division Multiple Access (CDMA). With CDMA technology, capacity is highly sensitive and directly linked to signal quality.

The only way to achieve the advertised high-speed throughput is to give users the best signal possible. Operators must recognize that cell sites located outside the facility are insufficient to provide an adequate signal as users move indoors.

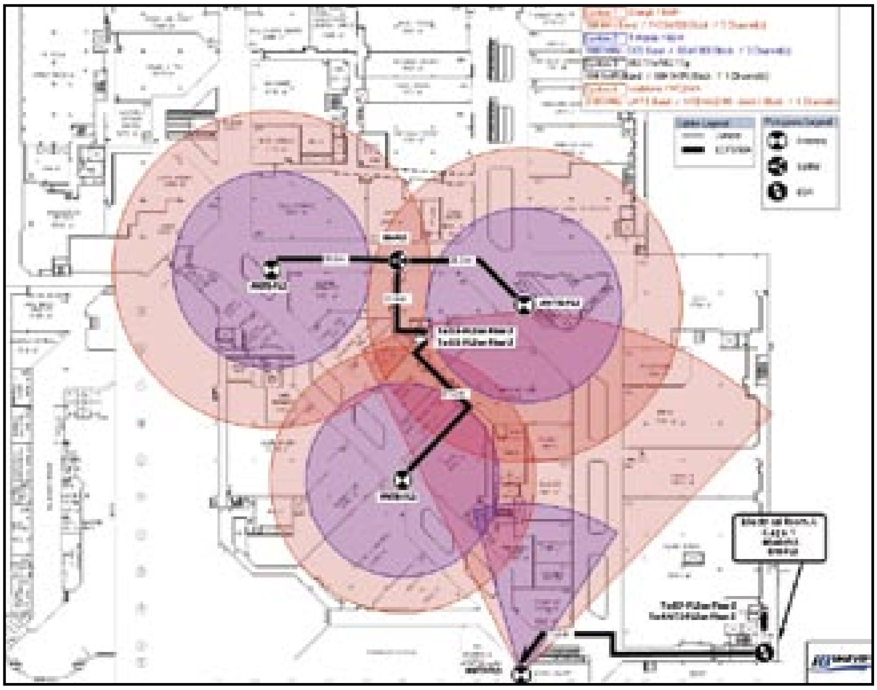
An Integrated Software Tool

What if you could use a software tool to create layouts of wired or wireless distribution plans? What if you could import floor plans and could drag-and-drop components to automatically create schematic diagrams, photo mock-ups, installations and bills of material?

In 2004, iBwave launched RF-vu, an integrated software tool for designing, commissioning and deploying complex in-building wireless networks. RF-vu lets designers converge technologies in a common architecture to support any type of system. The software supports all the technologies, bands and signal distributions shown in Table 1. It also offers features such as equipment databases, debug windows, advanced RF calculations, real-time linked schematic diagrams, and automated reports. Users



RF-vu Design Window



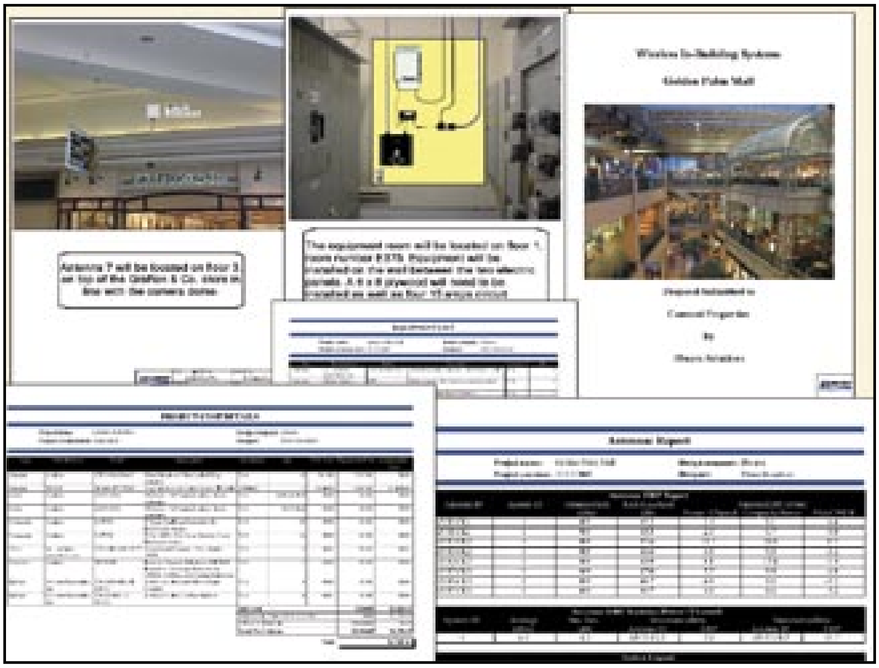
Property owners and installers can use the free RF-vu Viewer to review engineers' designs. Engineers, operators and integrators can collaborate using the Designer Pro version of RF-vu.

say that RF-vu increases design accuracy and cuts design process time in half.

RF-vu can import floor plans and use them in the design process. The software supports file types including PDF, AutoCAD DWG, JPG, BMP, GIF, TIF, PNG and PCX.

Fiber and Beyond

Radio-over-fiber technology has been gaining in popularity, especially for complex multi-carrier systems and 3G networks. Convergence, and the complexity brought by convergence, has created a demand for efficient wireless voice



Once a design is finished, RF-vu produces complete project documentation in a standardized format.

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and data infrastructure.

Approaches such as Distributed Antenna Systems (DAS) allow reductions in radio size, provide more uniform coverage at lower power and potentially reduce overall power consumption. Fiber DAS eliminates the need for independent systems by providing coverage and capacity for multiple wireless providers with a single fiber distribution backbone.

All of these advantages translate into lower operating expenditures for network operators, while providing consistent coverage and higher throughput for data-heavy applications. In its 2004 report, *In-Building Wireless Systems,* research firm ABI predicts that, by 2009, the penetration of radio-over-fiber will grow to 46 percent of the $993 million in-building market, from 18 percent of $664 million in 2003.

While fiber DAS creates efficiencies, it is complex to work with. However, RF-vu simplifies the design of fiber DAS systems with features like online access to up-to-date vendor equipment and component lists.

New York-based ISP Dianet Communications, Inc. takes fiber DAS to the next level, using RF-vu not only for in-building wireless high-rise projects but also for designing outdoor multi-carrier distribution systems that use lampposts and road signs. **BBP**

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