WIRELESS LAN APPLICATIONS

RAYLINK AND RAYTHEON ELECTRONICS WOULD LIKE TO ACKNOWLEDGE, AND THANK, THE WIRELESS LAN ALLAINCE FOR ALLOWING US TO USE PART OF THE PRECEEDING MATERIAL.

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Health Care

NORTHWEST HEALTH: GREATER PROFITS AND MORE COMPREHENSIVE CARE AT A SMALL CLINIC

Arriving for a hospital stay can be a difficult experience, but Sarasota Memorial Hospital in Sarasota, Florida, has made admissions much easier on incoming patients. Formerly, patients waited in the hospital's lobby until admissions reps were ready to process their paperwork. Now, because of a new wireless LAN, patients go right to their rooms, and admissions reps admit them there.

APPLICATION: PORTABLE HOSPITAL ADMISSIONS THROUGH A WIRELESS LAN
Tom Murphy, Sarasota's supervisor of network services, says that the hospital decided to look at admitting as a process rather than as a department or piece of first-floor real estate (which is at a premium in any health care institution). With that inspiration, Sarasota began a pilot wireless admissions program, which was so successful that the hospital ended up dissolving its admissions department and redesigning its lobby.

Now all patients (except outpatients, who check in at one of six stations in the lobby) are greeted at the door and assigned a room immediately. There they can make telephone calls, watch television, and relax while waiting for an admissions rep to arrive. The reps process admissions using notebook PCs equipped with wireless LAN cards. Through wireless access points strategically positioned on selected floors of the hospital (covering 150- to 200-foot areas through walls, ceilings, and floors), reps have uninterrupted, interactive access to data on the LAN from anywhere in the hospital.

BENEFITS: PROMPTER CARE, MORE COMFORTABLE PATIENTS - AND BETTER SERVICES FOR HOSPITAL STAFF
With the wireless LAN, each patient has one less stop to make. That means that Sarasota can make patients more comfortable while it speeds up admissions, and admissions reps are finding their jobs easier now that they're dealing with much more relaxed patients. Another plus: In the event of a disaster, triage teams can meet ambulances in the driveway and use the wireless system to begin admissions immediately.

But the benefits of Sarasota's streamlined admission process extend well beyond admitting patients. "Because patients are getting where they need to be on time, the wireless LAN also helps keep the nursing unit and areas like surgery and radiology on schedule," says Jeff Williamson, director of admissions before the change and now a project consultant.

And with the wireless LAN now accessible from most parts of the hospital, nurses can now track patient room changes and enter orders for lab work and patient services from portable PCs rather than terminals. A conference room has become an instant classroom. A hard-to-wire auditorium is now

equipped with PC demo facilities. And mobile workers, such as network services staff, can now access the network from other facilities.

THE AMERICAN RED CROSS PREPARES FOR DISASTER WITH WIRELESS LAN

The American Red Cross Disaster Service has more than 2,000 domestic chapters that maintain a supply warehouse and relief material for state and local-level disasters.

APPLICATION: RAPID DEPLOYMENT OF TEMPORARY LANs

When disaster strikes, the American Red Cross Disaster Service operates like a huge mobile warehouse, setting up, on a moment's notice, locations for receiving and storing thousands of pallets of food, supplies and equipment, and efficiently distributing those supplies to disaster victims. These operations often take place under extreme conditions: heavy storms, power and telephone outages, continuing floods and other logistical difficulties posed by the preceding destruction. Field houses for relief operations must be swiftly set up and often moved during the course of the operation. When relief needs have been met, they must be shut down quickly and the equipment made ready for immediate deployment to a new disaster site.

Prior to adopting a wireless application, the American Red Cross used paper-based inventory systems. Richard Hoffman, senior systems programmer with the American Red Cross-National Headquarters, said recent disasters demonstrated the need for a high-capacity, automated system.
The primary requirements for the new system were mobility, reliability, ease-of-use by staff and volunteer workers, and the ability to provide six to eight hours of continuous battery operation in the event of a power failure.

Secondary requirements included tight tracking of accounting and traceability records of materials and donated goods used during the operation, in order to meet IRS tracking requirements. The system tracks everything from perishables and water to equipment such as fax machines, cellular phones and tables and chairs. The system also maintains warehouse data and transmits that data to a central logistics database at the local disaster operational headquarters. (The Red Cross central logistics database enables it to provide a current inventory of all relief material on hand for the entire operation.)

BENEFITS: FLEXIBILITY, EASE OF SET-UP
FLEXIBILITY

The system provides mobile communication across large areas, through walls and over high stacks of relief supplies. In addition, the hand-held units were equipped to operate in a batch mode when out of range, which allows them to store the information until back in range. This eliminates the need to cover every square inch of the warehouse with radio frequency.

EASE-OF-USE

Since quickly trained volunteers with varying degrees of prior computer experience do much of the data collection and operation, a simple pen-based interface was chosen for the hand-held PCs.
Together, the components of the wireless system for the American Red Cross provide flexibility. In addition to having mobility and ease-of-use, the system can be easily expanded when necessary.

"The ability to quickly add new notebooks was a factor in choosing a wireless LAN system," Hoffman said. "Adding a workstation to the network is a fairly simple matter. And making future upgrades will be

INSTALLATION SIZE
The American Red Cross conducted an evaluation program of the system's inventory control and management capabilities at their national supply warehouse in Lorton, Virginia.
"Whenever the next disaster strikes, the system will be sent to the field for a trial under fire," said Hoffman.

After the product deployment has been completed and positively evaluated, a five-warehouse initial rollout of the complete system will begin. If initial installations prove successful, the software will be made available to more than 2,000 local Red Cross chapters across the country, for use in maintaining a supply warehouse and relief material for state and local-level disasters.

AUSTIN REGIONAL: WIRELESS-LINKED COMPUTERS
SPEED BILLING AT MEDICAL CLINICS

Medical clinics are fast becoming the leading alternative to hospital-based treatment. Austin Regional Clinic is a collection of multi-specialty clinics in Austin, Texas, employing 130 medical professionals who treat hundreds of patients a day. Austin Regional recently installed a wireless LAN to handle the increasing patient load and expedite insurance billing.

APPLICATION: MEDICAL PROFESSIONALS TRANSMIT PATIENT SERVICE INFORMATION DIRECTLY TO A BILLING SYSTEM

The billing system at Austin Regional's clinics used to be based on volumes of paper notes on treatments and services rendered to patients. Each doctor's notes had to be transcribed, checked, and corrected before they were passed on to insurance companies as bills for service. The paper system was expensive, and it prevented bills from being issued until at least two weeks from the date of treatment. To minimize the paperwork and its associated costs and to reduce the delay in billing, Austin Regional decided in 1994 to automate its billing process. It gave medical professionals at 11 of its 19 clinics pen-based, hand-held computers that would accept patient service information and transmit it to the central billing system. To link the computers to each clinic's central server, Austin Regional installed wireless LAN adapters on computers in each clinic's existing wired network.

Now medical professionals at Austin Regional can record office visits, lab work, X-rays, and other treatments and submit billing information on the spot. The wireless LAN uploads the information directly to the clinic's server; in turn, the hard-wired LAN transfers the information to the corporate database. Bills are issued within 24 hours of a patient's visit.

BENEFITS: FASTER BILLING, INSTALLATION AND MAINTENANCE COST SAVINGS, BETTER WORK FLOW

The wireless installation's primary benefit is that it lets the clinics recover costs more quickly, but it also "saves the costs of pulling cable and maintaining a cable-based network," says Audrey Nudd, chief information officer at Austin Regional. Plus, it gives medical professionals the freedom they need to walk from room to room while retaining full access to the server. Furthermore, says Nudd, "eliminating massive amounts of paper has not only reduced paper handling costs, it has cut down on transcription errors, which in turn has improved work flow." Nudd calculates that each clinic will fully recover the cost of installing its system only 1.2 years after the date of installation. Even more important, the wireless system gives medical professionals at the clinics a tool that is quick and easy to use.

INSTALLATION SIZE

Austin Regional's wireless system is now in place at 12 of its 19 clinics, where more than 250 wireless adapters have been installed in both mobile computers and stationary PCs. Plans to expand the system to the remaining clinics are under way.

MERCY MEDICAL CENTER IMPROVES EFFICIENCY AND QUALITY WITH WIRELESS LAN TECHNOLOGY

Mercy Medical Center of Springfield, Ohio, has embraced a new wireless LAN technology that helps the hospital reach its goals of treating patients quickly, efficiently and accurately.

APPLICATION: WIRELESS SYSTEM DESIGNED TO PROMOTE MOBILITY AND EFFICIENCY
At Mercy Medical, case managers are responsible for gathering authorizations from insurers for procedures and length of patient stays. Prior to implementing a wireless LAN, this process required two steps: gathering information and recording it to the hospital
information system (HIS). Now Mercy is able to consolidate these two steps into one.

Mobile case managers gather and record information directly to the HIS via a portable workstation, without traveling to wired workstations or plugging into ports. Direct recording provides hospital staff with information they need in real time, helping Mercy expedite patient care and contain costs. Furthermore, because each case manager covers two or more geographical areas within the hospital, the wireless LAN helps Mercy avoid the cost and space constraints of maintaining a separate workstation for a case manager in each area.

Case managers also monitor the quality of each patient's infection control, risk management and general care. Before the wireless LAN, these were separate departments, and coordinators form each department would routinely review all charts for potential high-risk patients. The wireless LAN has allowed Mercy to redesign the process so that case managers screen the charts for all functions within the departments, such as quality, risk management and infection control issues. Collected data is entered into the hospital's managed care system, and the appropriate coordinator receives information on a particular patient only if follow-up is needed.

BENEFITS: WIRELESS LAN SPEEDS COST CALCULATING AND ADMISSIONS
Having a mobile workforce has transformed the efficiency of Mercy's processes. The hospital has improved its cost containment, as well as quality of care, and is now working to make hospital admissions a faster procedure.

WIRELESS COST CALCULATING
Mercy coders are responsible for translating diagnostic and care procedures recorded on patient charts to a standard code. Insurers then reimburse Mercy according to the codes. Before Mercy implemented the wireless technology, staff coded information after patients left the hospital. That meant Mercy could calculate the cost of care only after providing it. Once Mercy began using a wireless network, coders could gather information from patient charts still in circulation.

Through this type of concurrent coding, the hospital's coders can more accurately do their jobs because they can interact with the physician while a patient is still at the hospital. Coders have a complete, accurate listing of a patient's diagnosis on the chart at the time of a patient's discharge. Another benefit is the ability to have the diagnosis statement available for the doctor to sign at a patient's discharge. Coders don't have to wait for the doctor's signature at a later time and can immediately bill the patient.

"This new procedure, made possible through wireless technology, makes the coding process faster and more accurate," Therese Riehle, Mercy's director of Care Coordination, said. "Therefore, we are able to more quickly establish a patient's cost of care."

MOBILE ADMISSIONS
Mercy is currently working on using their wireless system to admit patients more quickly. From the emergency room, mobile admissions clerks admit those patients moving to the main hospital. Mobile admissions clerks also admit children after they have arrived in pediatrics. Mobile admissions nurses speed caregiving for all patients by planning and ordering procedures from patient bedsides. In this way, says Riehle, Mercy has "the ability to take the admitting process to the patient."

INSTALLATION SIZE
Mercy Medical Center's wireless system consists of 20 wireless devices supported by six hosts.

SAINT JOSEPH: WIRELESS LAN HELPS HOSPITAL MEET MANAGED HEALTH CARE CHALLENGE

Managed health care is based on predefined fees for medical procedures. However, those predefined amounts often are lower than the amounts that hospitals otherwise would charge to cover costs. To continue delivering superior patient care, hospitals are looking for ways to manage the costs of patient visits and procedures more closely. Denver-based Saint Joseph Hospital, founded more than 100 years ago, is recognized for excellent care at very competitive rates. In 1995, the information services group at Saint Joseph took a look at what emerging information technologies could do to help the hospital maintain its strong competitive position.

APPLICATION: ACCESS TO PATIENT RECORDS AND MEDICAL REFERENCE HELPS NURSES KEEP PATIENT CARE ON TRACK

The hospital's plan was to put access to information - both patient records and the hospital's medical reference library - closer to the point of care. Doing so would allow the hospital to analyze and manage patient information more closely and concurrently, and control the costs of patient visits and treatment.

"Our goal was to choreograph a patient's stay, detailing exactly what needed to happen and when. We saw that one of the most effective ways to ensure that everything happened according to plan would be to give nurses access to patient records directly from a patient's bedside," said Douglas Hahn, Manager of Information Services at Saint Joseph. "We knew we could provide the required care without excess costs by following a carefully defined process."

The hospital wanted nurses to be able to chart patient information from bedside. The information services group already planned to replace the existing mainframe-based network with interconnected Ethernet LANs, so it considered extending the hard-wired network to each room in the 600-bed hospital. However, Hahn quickly recognized major disadvantages in that plan. First, the cost of installing cable and purchasing PCs for every room would be prohibitive. Also, unintelligent terminals would not provide the computing power that nurses would need to run applications or access patient records stored on CD-ROM. Furthermore, in pilot tests, patients found the fan noise from the computers annoying. Because the building was not new, laying cable would be difficult, and in many hospital rooms there simply wasn't enough space for a computer. Finally, Hahn feared that PCs installed in hospital rooms would be exposed to tampering, which could result in damage either to the equipment itself or to the security of the information on the network.

The hospital overcame all of those obstacles by using wireless LAN technology instead of extending the wired network to every room. A specially designed cart carries nurses' supplies, such as alcohol swabs and I.V. caps, as well as a laptop computer with a wireless LAN adapter. Nurses take the carts with them from room to room, using the laptops to enter information or access patient records. Before the hospital installed the wireless system, nurses took notes on patient information and later entered the

information on a patient's paper chart. Now, nurses can enter patient information on the spot, and a clinical application on the network makes the information easy to chart. When a patient arrives, the hospital maps out every aspect of the patient's stay - what treatments the patient should receive, and how long the patient should stay in various departments - according to the managed care prescription for the procedure in question. Nurses use their access to the up-to-date information on the network to make sure that each patient is treated according to plan. "Although people often resist new technology, we were able to make it easy for the nurses to use the new applications and the wireless units, so the new system isn't a burden to them. It has been very successful," said Hahn.

BENEFITS: MINIMIZED INSTALLATION AND MAINTENANCE COSTS, STREAMLINED PROCEDURES, BETTER SECURITY

The most obvious benefit of the wireless system was its cost: By installing a wireless LAN, Saint Joseph avoided purchasing, installing, networking, and maintaining a huge number of PCs. However, the wireless LAN's advantages go far beyond equipment savings. Entering information directly into the network eliminates the step of reentering handwritten information into a central terminal and reduces the chance of transcription errors. In addition, because nurses take their laptops with them wherever they go in the hospital, the equipment and the network are secure.

INSTALLATION SIZE

Saint Joseph now has 70 carts with notebook computers on the wireless LAN. Ten access points connect the LAN to the hospital's Ethernet network. Hahn said Saint Joseph plans to expand its use of wireless technology. "We are looking at providing other groups in the hospital with wireless capabilities. Physical therapists, for example, often go from room to room or floor to floor, and it's inconvenient for them to use a stationary PC. With wireless units, they'll be able to access and update patient records or other information from anywhere in the building." Another advantageous use of wireless technology that the hospital is considering: By using a wireless LAN to link surgery rooms to the hospital network, Saint Joseph can avoid both the risk of contaminating the rooms and the need to shut them down while cable and other hardware are installed.

Trading & Banking

NYSE AND AMEX: WIRELESS TRADING CATCHES UP WITH STOCK AND OPTION TRADERS

Stock and option trading is a venerable institution - some stock exchanges are centuries old, as is the practice of writing option contracts. Today, while trading's importance to the world economy is monumental, traders still make transactions by shouting, waving, and scribbling notes on slips of paper. At the NYSE and the AMEX, the shouting and waving may go on, but these exchanges will soon trade paper notes for the speed and reliability of wireless networks.

APPLICATION: TRACKING AND FACILITATING TRANSACTIONS ON THE EXCHANGE FLOOR
The wireless networks at the NYSE and the AMEX will extend networking technology into places where no network was possible before. Both the NYSE and the AMEX already have phone and wired computer networks that allow clerks in the booths above the exchange floor to communicate with the outside, say a brokerage's main office. When orders reach the clerks, however, they reach the end of the wired road. The clerks write each order on a ticket, which a runner then takes to the appropriate broker on the floor. Once the broker makes the transaction - either through another broker ready to buy or sell or through a "market maker" - he or she records the transaction and gives the receipt to a runner; the runner brings it to a clerk, and the clerk enters the transaction information on a computer for relay back to the main office or transaction clearing partner.

Now the NYSE and the AMEX are developing a wireless backbone that will replace the runners and paper tickets between the clerks and the brokers with hand-held wireless computers. Both systems will be available for use by any member firm. When the NYSE infrastructure is complete, any member firm will be able to use it to transmit information directly between their clerks in the booths and the traders on the floor. Says Robert Britz, NYSE group executive vice president, equities, "The system will complete the loop of technological enhancement that the NYSE has been implementing over the past two years." AMEX rules will allow direct wireless communication between traders and their brokerages or clearing partners outside the exchange. In both exchanges, transactions will be recorded as they happen, speeding up the entire trading process and paving the way for an array of benefits to firms, their clients, and the exchanges.

BENEFITS: SPEEDIER, HIGHER QUALITY INFORMATION
BOTH TO AND FROM THE FLOOR
The wireless networks at the NYSE and the AMEX will give brokers instant access to proprietary information. Instant number-crunching power will be another important benefit: On their hand-held computers, traders can even run proprietary algorithms and run what-if scenarios right on the floor - a crucial advantage in the volatile world of option trading, where traders make huge buying and selling

decisions on price shifts of mere pennies and timing is even more crucial than in securities trading.

And with transactions entering the system instantly, brokers and traders will be able to make better decisions. Under the old system, analyticals (the information on share prices and underlying variables that indicates the price levels at which options should trade) were manually updated, a process that took 24 hours or more. With the new system, option traders will always have up-to-the-minute analyticals at their fingertips.

Other benefits of the wireless network include the reliability and accountability it will lend to transactions. Because transactions are made and recorded all in one step, they won't get lost. And because every step of every transaction takes place electronically, auditors will be able to follow an audit trail through the network for any transaction at any time. Thus the wireless networks will allow the exchanges to implement a level of oversight that wasn't possible before.

INSTALLATION SIZE
NYSE: With its first broker on-line at the end of 1996, the NYSE has scheduled its wireless system for full rollout in the second half of 1997. The system will ultimately help bring more than 1,300 traders and NYSE staff members on-line by providing them with hand-held computers equipped with wireless cards that connect them to the wired network.

AMEX: AMEX is installing access points; this wireless infrastructure will serve 200 AMEX personnel and 1,000 individual firms and traders, who will supply their own hand-held computers and wireless cards.

Education & Research

STUDENTS AND FACULTY ON SAME WAVELENGTH AT SUNY MORRISVILLE

"WIRELESS LAN PRODUCTS AID NEW YORK COLLEGE IN BECOMING AMERICA'S MOST-WIRED TWO-YEAR COLLEGE"

In this time of changing technology, our administration asked itself how it could create a more interactive learning environment for our students to better prepare them for the workforce. At SUNY Morrisville, in addition to focusing on collaborative learning, we wanted to promote an atmosphere where students could learn at the location best for them.

APPLICATION: LINKING WIRED AND WIRELESS NETWORKS
Instead of relegating students to the library or classroom while working on projects, we wanted to give them the flexibility to have access to the university network and email from anywhere on campus, including from their dorm rooms, dining hall and outside.

We were able to accomplish one part of our goal by integrating the use of notebook computers into our curricula. This afforded students the ability to work in groups without being relegated to a computer lab. However, the students were still tethered to data ports for a connection to the Internet or the campus network.

We decided the best solution would be to provide our students with a wireless LAN connection. Our president, Ray Cross, Ph. D., is a major proponent of implementing the latest in technology within our campus' infrastructure and played a major role in having our entire campus connected to a wireless LAN (WLAN). Every academic building and residential hall on campus is now equipped with wireless network connectivity.

While conducting research to find a viable wireless network supplier, considered three potential vendors. Of the three candidates, Southern California-based Raylink™, emerged as the definite choice. The company was the only WLAN provider that met all of our wireless network criteria. We were sold on the product's ease of implementation and use as well as strength and reliability of the signal it emitted.

The company's use of the frequency hopping spread spectrum (FHSS) technique throughout their products gave us the decided edge we were seeking. Since the system's signal path is more resistant to outside interference from electromagnetic sources such as appliances and other wireless LAN devices, they were ideal for extending our school's LAN environment. Raylink's FHSS design appears to be immune to interference jamming, unauthorized detection and noise, unlike other WLAN technologies based on direct sequence spread spectrum (DSSS).

Another compelling factor behind our decision in choosing Raylink as our wireless connectivity provider was that the company's connectivity equipment maintains signal strength and throughput from extended distances. Aside from its impressive array of signal strength and reliability features, the products were also completely in line with our budget. Raylink's suite of WLAN products seamlessly fulfills SUNY Morrisville's wireless connectivity needs.

BENEFITS: ACCESS TO CAMPUS NETWORKS AND INTERNET, ANYWHERE, ANYTIME.
By integrating these products, our original mission of offering our students a nomadic learning environment is now complete. Students can now access the Internet or have a live connection to our network from anywhere on campus at any time. Additionally, if it's a nice day, they have the opportunity to take advantage of the weather, whether they are conducting research on the Internet or working in groups on class projects on the lawn.

Having been in place for a little more than a year (fall semester 1999), the wireless products have become mainstay of our campus culture. Currently more than half of our student population (1,600 out of a population of 3,035) is connected to our WLAN with wireless cards. Through the vision of individuals like President Cross and Assistant Vice President of Technology Services Jean Boland, SUNY Morrisville was the first campus among SUNY's 64-school system to implement wireless technology. Thus far, our wireless campus has been so well received that we were recently named "America's Most Wired Two-Year Institution" by *Yahoo! Internet Life* magazine. Our school was selected from a pool of nearly 1,300 schools located in all 50 states. The campus connectivity has been such a rousing success that the students who aren't connected comment that they are suffering from 'wireless fever.'

In lieu of waiting for a professor's office hours, and hoping there is no line of people in front of you, students may simply email any queries to their professors. This wireless technology has now opened up communication lines between students and faculty on virtually a 24-hour basis. Instead of limiting the human interaction between student and professor, interaction has actually increased. Since some questions can be answered by e-mail, students and faculty can get to know each other on a more personal level during office hours.

While the wireless connectivity hasn't turned classrooms into paperless environments, it has eliminated some of the paper shuffle that occurs. Instead of turning in an assignment in class, students are now able to deliver homework into a professor's inbox via the WLAN. Many classes have also gone to CD-ROMs in lieu of textbooks. In a pilot program within the engineering department, the professor took a poll of who favored CD-ROMs over textbooks and the students were unanimous in their choice of the CD-ROM version.

Aside from getting the thumbs up from our students, the faculty in the laptop curricula have also been very receptive to the new wireless environment. Less cords means less set-up time for class lectures. Since professors are able to work anywhere on campus via their laptops, including the dining facilities or quad, they are also taking advantage of the increased mobility and freedom the products have provided. Rayklink's suite of products has also allowed our faculty more latitude to finish work away from their offices on campus.

Complimenting our existing LAN environment with wireless connectivity has resulted in a win-win relationship for everyone involved at SUNY Morrisville. Moreover, our relationship with Raylink has been very positive. The company was extremely responsive and reacted very quickly to one of our emergency product requests. Everything we asked for arrived the next business day.

INSTALLATION SIZE

There are 1,600 units using Raylink's wireless LAN products as of January 17, 2001.

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MAJOR UNIVERSITY PROVIDES PLATFORM
FOR WIRELESS RESEARCH

Carnegie Mellon University, in Pittsburgh, Pennsylvania, is ranked among the nation's top 20 private research universities. Its Information Networking Institute, the first research and education center devoted to information networking, received an endowment from the National Science Foundation to create an experimental high-speed wireless network. Dubbed "Wireless Andrew," the network is now in the testing stage.

APPLICATION: LINKING WIRED AND WIRELESS NETWORKS

Wireless Andrew is a 2-megabit-per-second wireless local area network connected through access points to the wired Andrew network, a high-speed Ethernet backbone linking buildings across the Carnegie Mellon campus. The combination of networks gives high-speed access to any user with a portable computer and a wireless LAN card from any building covered by access points. In addition, a low-bandwidth wide area network that covers the greater Pittsburgh area provides researchers and others with off-campus wired access to campus networks.

Campus network services include e-mail and file transfer, access to audio and image data, access to the library and other databases, and full Internet access.

BENEFITS: INCREASED ACCESS TO CAMPUS NETWORKS AND
CREATION OF LEADING RESEARCH PLATFORM

The Institute's wireless initiative not only serves the campus community by increasing high-speed access to campus networks. It also provides an infrastructure for research in wireless communication. As the university's Dr. Ben Bennington points out, "What makes us different from other wireless technology customers is that we're not implementing an application; we're implementing infrastructure, a kind of 'honey pot' to attract people to mobility research."

In the area of infrastructure, Carnegie Mellon has anticipated the need for the next generation of systems to integrate wired and wireless networks by giving researchers a platform for developing and testing "middleware" - software that allows seamless access to the various wired and wireless networks which a roaming computer encounters.

As for mobility research, the system will provide a major test bed for Carnegie Mellon and its sponsors, giving researchers in many fields, inside and outside the university, a way to explore the uses of mobile computing. Programs include systems research, development of computer platforms for mobile use, compression research, and research on the human factors of mobile computing. The Institute's ongoing development is resulting in numerous innovative uses of wireless LANs, including emergency response, health care, and vehicle maintenance. One project involves communication with trains to download diagnostic data. Another involves "wearable computers" - a project for developing innovative maintenance systems that free technicians' hands while still giving them access to engineering drawings and other information.

INSTALLATION SIZE

Wireless Andrew consists of 100 access points covering six buildings on the Carnegie Mellon campus. The university tested the current setup with over 40 mobile units before allowing general use by researchers and students in February 1997.

Warehouse & Manufacturing

MITSUBISHI CATERPILLAR FORKLIFT AMERICA: WIRELESS SYSTEM LIGHTENS THE LOAD OF HEAVY EQUIPMENT MANUFACTURER

Mitsubishi and Caterpillar formed their joint venture, Mitsubishi Caterpillar Forklift America (known as MCFA), by revamping a plant in Houston and giving it the capacity to custom-build as many as 60 forklifts a day. By doubling the workforce overnight and dramatically increasing output, the consolidation put enormous pressure on the plant's work-in-process and employee attendance systems. MCFA's new wireless tracking system took the pressure off.

APPLICATION: FACILITATING WORK-IN-PROCESS AND TRACKING TIME AND ATTENDANCE
MCFA manufactures custom-built forklifts, not just one standard model: A customer can choose a gas-powered, electric, or diesel engine, for example, or opt for pneumatic or cushioned tires. Assemblers typically do not know what type of unit they will be working on until they receive a work order. Any delay in getting the required parts to assemblers eats up production time.

Before MCFA installed its wireless system, the plant tracked all work-in-process manually. The delay between transactions and data entry made it difficult to track the manufacturing process, accurately forecast production, or adjust for production delays. "When a part came in to the receiving dock, it took up to several days before someone entered that information into the computer system," says Roy McCartney, system architect for the plant's information services. "In the meantime, the assembly line couldn't use the part." And MCFA could only tell a customer that it was either working or not working on the customer's order; it couldn't provide more details on the order's status.

With MCFA's new wireless system, tracking of work-in-process and employee time and attendance are both automatic. Using hand-held wireless computers, workers at the receiving dock key in information about parts received as soon as each part shipment arrives, and workers on the assembly line track work orders in progress.

BENEFITS: FEWER PRODUCTION DELAYS, BETTER CUSTOMER SERVICE,
AND SMOOTH HANDLING OF A GROWING WORK FORCE
Now production delays have declined, the plant operates more efficiently at every stage, and MCFA's customers appreciate the progress reports they get on the status of their orders. Plus, the wireless system has helped management smoothly handle the influx of new employees at the plant. McCartney goes so far as to say that "with the plant's growth in product output and employees, it would have been impossible to continue manual tracking."

ORBIT IRRIGATION PRODUCTS, INC.: WIRELESS SYSTEM GETS PRODUCTS FROM WAREHOUSE TO CUSTOMERS ON DEMAND

Orbit Irrigation Products, Inc., is an industry leader in both residential and commercial markets. The 300-employee manufacturer distributes products to all 50 states and many countries from four distribution centers, including its main center in North Salt Lake, Utah. Orbit's business is highly seasonal, and during spring and summer demand can increase rapidly. Now a wireless network lets Orbit process and ship orders as quickly as necessary to meet that demand.

APPLICATION: AUTOMATING WAREHOUSE OPERATIONS AND ELIMINATING DELAYS

During lulls in business, Orbit's paper-based inventory control card system was adequate, but during peak selling seasons, it was slow and inefficient enough to cause problems, and rapid sales growth was making things worse. Phantom or misplaced inventories hamstrung operations in Orbit warehouses because they were difficult and time consuming to locate. Forklift drivers would roam aisles at random, looking for places to stock overhead inventories. And every shipping delay potentially led to an order being cancelled and business lost to a competitor.

"We needed a system that ensured that our inventory was accurate and directed our workers as efficiently as possible, but that didn't break the bank," says Shawn Stephens, Orbit's warehouse inventory sales manager. "A wireless system, which would allow real-time warehousing transactions and bar code verifications, was the only way we could both keep down labor and inventory costs and raise customer satisfaction."

Orbit's new warehouse system includes wireless hand-held computers equipped with long-range scanners that can read bar codes even on upper storage locations. Warehouse operators use the system to transmit receiving, putaway, picking, and shipping data to the central warehouse management system; with each warehouse transaction, the system updates inventory automatically.

BENEFITS: HIGHER PRODUCTIVITY AND RELIABLE INVENTORY FROM A SYSTEM THAT PAYS FOR ITSELF

Orbit's 65 Utah warehouse employees now process 20 to 30 percent more orders every day. And now that warehouse operators can find products on demand, picking and shipping delays are a thing of the past.

"Before we computerized our warehousing system, we had one person searching the aisles daily looking for products," says Stephens. "We just don't need to do that anymore." The new wireless system lets Orbit use random putaway as well as dedicated putaway, so while Orbit is making better use of storage space and doubling the hourly output of forklift operators, it's eliminating product "outs" in dedicated pick locations.

Adds Stephens: "We're on schedule to have the system pay for itself in less than 18 months."

BAYER: WIRELESS SYSTEM KEEPS VAST INVENTORY ON TRACK

Bayer, Inc. (formerly Miles Canada, Inc., and belonging to parent company Bayer AG of Germany), sells more than 25,000 different stock keeping units, or SKUs, to businesses ranging from local drug stores to the Big Three U.S. auto makers. Bayer stays competitive and handles an influx of new products thanks to a wireless system it installed in 1995.

APPLICATION: REAL-TIME DATA COLLECTION AND INVENTORY MANAGEMENT

In the early 1990s, Bayer consolidated four of its companies into one. At the same time, its products multiplied and its customer bases (in health care, chemicals, and imaging technologies) ballooned. Some 55 Bayer employees in Canada (operating warehouses totaling 185,000 square feet with dozens of loading docks) had more product to inventory than the batch processing system could handle. High volume and the potential for human error were resulting in too many mistakes.

To design an ideal warehouse management system, Bayer organized a 10-person steering committee of warehouse managers and operators. Says Harold Mueller, Bayer's director of logistics, "First on our list was a real-time database transmission system to save money, reduce person hours, cut down on paperwork and improve employee efficiency. Our tremendous volume of diverse products required it. A batch system isn't updated in real time, and it makes taking accurate inventory difficult."

After analyzing the types of product stored and determining the number of base stations required to cover the employees in each warehouse, Bayer chose two systems: For three of the warehouses, it chose hand-held radio-frequency data terminals with laser scanners, keypads, and bar code readers; and for a fourth warehouse, where hazardous materials are stored, Bayer chose an impact-resistant radio-frequency terminal system. Both systems operate in an IBM AS/400 minicomputer environment, and both have a modular design that makes upgrades easy.

BENEFITS: DRAMATIC IMPROVEMENTS IN DISTRIBUTION, TRACKING, AND QUALITY CONTROL

Using the wireless system, a warehouse operator can process an individual order in less than 30 seconds. Bayer now ships 24,000 orders per month with shipping and inventory accuracies of over 99 percent - and virtually no complaints. Most distribution is paperless: Through an EDI link (an on-line shipping, tracking, and payment system), Bayer advises its carriers of shipments and payments without waiting to receive and pay invoices. The system automatically routes and checks in products for destination, weight, and class. Warehouse operators can find out what's available at any instant, and instead of being a separate job, inventory counting is part of every operator's routine. What's more, now employees know that inventory is accurate.

Tracking has become vastly more efficient now that Bayer service staff can now get instant information on the status of a customer order. And as for quality control, products are quarantined as soon as employees report any damage. According to Mueller, the risk of sending out damaged products has been virtually eliminated.

With such high volume and so many products, the wireless system's real-time transmission capabilities have become an essential component of Bayer's business.

INSTALLATION SIZE
Bayer's installation (in the three warehouses where hazardous materials are not stored) consists of 46 hand-held terminals linked wirelessly to the AS/400 minicomputer, a printer, and scanners.

KRAFT: WIRELESS SYSTEM KEEPS TRACK OF PRODUCTS IN DISTRIBUTION CENTERS

Kraft has been a household word for decades - consumers take home Kraft products from virtually every grocery store, supermarket, convenience store, and discount store across North America. The coordination and planning it takes to move all those products to the stores where consumers buy them could be daunting. Now, though, Kraft Canada's wireless system makes that task a lot less labor intensive than it used to be.

APPLICATION: USING WIRELESS DATA TERMINALS TO TRACK FINISHED GOODS THROUGH WAREHOUSES
In the early 1990s, Kraft Canada made a commitment to implementing new technology to automate its manufacturing plants and distribution centers. It began with a progressively integrated manufacturing and materials requisitioning and purchasing system, or MRP, in its seven Canadian manufacturing facilities. That system's success spurred Kraft to pilot and then install a wireless data collection and warehouse management system at its Montview distribution center, one of three in Canada. "Although the batch system worked well at our manufacturing facilities, we needed real-time data transmission at our distribution centers. Now our inventory is up-to-the-minute," says Daniel Lanctot, senior systems analyst at Kraft Canada.

Kraft Canada uses the wireless system for everything from receiving and putaway to inventory and quality control. Sixty-five forklift-mounted data terminals and 10 hand-held data terminals with integrated bar code scanners, all running off an IBM AS/400 host computer, dynamically direct forklift operators to complete specific tasks.

From the moment goods arrive at a warehouse until they're shipped, the system tracks their movement. "When product comes in the door," says Lanctot, "an operator scans the bar code tag to transmit the product description, quantity, lot number, and pallet number to the host computer. The host then generates a putaway task indicating the appropriate location, and automatically downloads it to the appropriate forklift operator's terminal."

When an order comes in, the warehouse management system automatically uses inventory rotation dates to generate a picking task, which dynamically directs a forklift operator to start building a load. The forklift operator first scans a bar code that describes the product's location, then scans a bar code on the pallet to verify that they match. Because the system can tell full pallet picks from multiple product picks, it knows whether to direct the forklift operator to a full pallet pick location or to a case picking location.

Once the forklift operator finishes a load, the dispatcher generates a bill of lading and sends the operator to the correct shipping dock. At the dock, the forklift operator gives the carrier the bill of lading, a warehouse operator scans the load, and the dispatcher confirms that it matches the bill of lading before the carrier takes it away.

Using special re-warehousing and replenishment programs, Kraft even uses the wireless system to optimize space. The programs automatically download trip tasks to forklift operators' terminals,

directing them to move pallets according to lot numbers and rotation dates.

**BENEFITS: MORE EFFICIENCY, HIGHER PRODUCTIVITY,
AND DEPENDABLE INVENTORY**
Inventory accuracy at the Montview distribution center has risen to 98 percent or more, and - because virtually every warehouse function is recorded on-line - Kraft can check inventory status at any time with confidence that it's correct. The re-warehousing and replenishment programs are an effective way to free up space to receive new product. As for customer service, Lanctot says this: "Now we know we're shipping the right product in the right quantity to the right customer at the right time."

Kraft soon afterward installed similar systems at its Lasalle and Cobourg distribution centers. And to enhance service to its customers even further, Kraft Canada is also planning to integrate an EDI link (an on-line shipping, tracking, and payment system) into its wireless systems.

FORD: WIRELESS LANS IMPROVE QUALITY AND EFFICIENCY AT TRUCK PLANT

Henry Ford's Model T - state of the art in its day - changed the way products were manufactured around the world. Ford's new advanced wireless tracking system builds on the company's reputation for innovative automation technology.

APPLICATIONS: QUALITY CONTROL MONITORING, MATERIALS TRACKING, AND INVENTORY MANAGEMENT

Ford's Kentucky Truck Plant in Louisville is over 4 million square feet in size and produces over 200,000 trucks annually, each a composite of thousands of parts. The plant operates on the world's largest wireless quality control monitoring, product tracking, and inventory management system. Quality control inspectors, forklift operators and clerks, and shipping staff use wireless, pen-based portable teletransaction computers, or PTCs, throughout the manufacturing process.

Before the wireless system was installed, quality inspectors noted defects on forms, and repair people initialed the forms when the repairs were finished. However, errors took hours or sometimes even days to identify and correct, so inspectors often didn't find out about problems with a truck until well after the problems had originated.

QUALITY CONTROL MONITORING

Ford wanted to keep quality control as simple as possible, so the new system had to involve minimal data entry. In fact, it ended up making the process even simpler. Now, after entering a personal access code into a PTC at the start of a shift, each inspector makes choices from a series of lists displayed on the screen, without writing down anything at all. And all information entered on the PTCs, which can be used anywhere in the manufacturing complex, is transmitted instantly to a central mainframe computer.

At the start of the manufacturing process, each manufactured unit is assigned a serial number. As a unit enters an area of the plant, the inspector's PTC lists the options pertinent to that area and shows which options were ordered for that particular truck. The inspector enters the inspection results for each option - defect or no - on the PTC. Farther on down the assembly line, in the same area of the plant, a quality upgrader's PTC displays the defects to be corrected. The system effectively prevents a unit from being sent on to the next area until the upgrader notes that all defects have been repaired.

MATERIALS TRACKING

Ford also applied the wireless LAN to materials tracking: The system tracks every component and box of material that enters the facility to its consumption point on the assembly line.

INVENTORY MANAGEMENT

The wireless LAN even extends outdoors to the ship-out yard - which often holds more than 1,000 trucks - where PTCs are used for tracking finished product inventory. The wireless system not only tracks every truck's location in the yard, it tells the shipping staff why the truck is there: whether it's scheduled for an engineering change, whether it's due to a third party for aftermarket work or body work, or whether a finance issue must be resolved before a truck can be shipped out.

BENEFITS: MORE COMPETITIVE PRODUCTS, LESS PAPERWORK, BETTER TRACKING AND INVENTORY MANAGEMENT

The wireless LAN makes possible a level of quality control that contributed to the successful launch of Ford's F-series trucks. "The system lets us correct problems before components leave their specified area," says Ishmael White, Plant Floor Systems Manager. "We don't wait to go back and correct them later, so we can make repairs more reliably. The system also lets us react very quickly to trends that start to develop - say, where the same error is occurring repeatedly - which saves on the time and cost of repairs. Even in the rare case where a defect isn't discovered until later on, the system lets us trace it back to the area where it originated so that we can find out what went wrong and address the problem."

Because all of the information transmitted over the wireless LAN is collected in real time in a central database, inspectors can get the information they need on the spot simply by querying the database - there's no more need to generate reports or tally inspection forms. Most reporting is done online, too. The result has been a drastic reduction in paperwork.

Finally, the wireless system has dramatically improved both materials tracking and inventory management, reducing the amount of material tied up in manufacturing by two thirds since 1990.

INSTALLATION SIZE

The wireless LAN installation started out serving about 300 plant inspectors and other workers at the Kentucky Truck Plant. Now the number of users at the plant has gone up to 450; two completely redundant wireless networks with a total of 160 access points and antennas guard against downtime. Ford is now implementing wireless LANs at other manufacturing plants and distribution centers worldwide.

OCEAN SPRAY IMPLEMENTS WIRELESS LAN
AND BOOSTS PRODUCTIVITY

Ocean Spray's Kenosha, Wis., warehouse is one of six regional manufacturing/warehousing distribution facilities for Ocean Spray. While each produces juice from locally-grown fruit, all facilities distribute the full Ocean Spray product line in their region. That requires considerable inter-warehouse shipments.

Prior to adopting a wireless LAN technology at the Kenosha warehouse, two people were dedicated to walking around the 300,000-square-foot warehouse just to find open storage locations for incoming pallet loads. When it was time to pick cases of the company's juice products, workers had troubles reading the pallet case markings. Tracking of shipments by customers required many hours to review paperwork and determine who received which products from which lots.

APPLICATION: BRINGING WIRELESS TO THE WAREHOUSE
When the managers of the Ocean Spray Kenosha warehouse faced an increase of 15 percent in case volume and a 10-percent increase in SKU count, it was time to make a change in their inventory information management system. They decided on a wireless system, and today, every lift truck in the Kenosha warehouse is outfitted with a radio frequency data communication (RFDC) terminal. All storage locations are bar coded, as is every pallet load. A warehouse management system (WMS) coordinates activities, from receiving through shipping of finished goods. To maximize efficiencies, the server that the WMS systems runs on at Kenosha is fully integrated with the mainframe at Ocean Spray's corporate headquarters in Middleboro, Mass.

"This interactive transaction interface makes the data in our corporate system as current as the last bar code scanned on the floor," Manager of Application Development Pete Stirling said.

With the new system, pallet loads arriving from another warehouse have a bar-coded pallet label, including the product identification number, product code date or expiration date, the plant of manufacture, line of manufacture and a sequentially-assigned serial number. A lift truck operator scans the label in receiving. The RF terminal sends that data to the warehouse software, which immediately designates a storage location and relays it back to the RF terminal on the lift truck. Every storage location is identified by a bar code label, either suspended from the ceiling for floor locations, or attached to a rack face. The operator scans that bar code to confirm putaway in the correct location.

At headquarters, the mainframe receives orders by Ocean Spray's electronic data interchange (EDI) network. It then releases orders to locations. At Kenosha, the WMS manages order picking, balances work loads, and selects pick sequences for lift truck operators. The dock control module then releases orders for picking.

 Each line item and quantity required appear on the designated lift truck's RFDC terminal. To confirm accuracy, the operator scans the bar code label on the full pallet or at the rack location for less than full pallet picks. The RF terminal directs the operator to the designated dock door for immediate loading on an over-the-road trailer, all under the control of the warehouse software. Using the inventory data captured by the RF terminals, the WMS automatically generates the pack list and bill of loading for each

over-the-road trailer. Confirmations of line items picked and shipped are then sent to the mainframe for invoicing.

BENEFITS: INCREASED PRODUCTIVITY
The results of the wireless technology have been substantial. Beyond eliminating the original inefficiencies, the automatic data collection (ADC) system allowed Kenosha to ship an additional 1.8 million cases of the product in 2,200 fewer worker hours during the first year. Hourly productivity increased from 451 to 550 cases handled per worker. In addition, inventory accuracy now exceeds 98 percent, and inventory turns increased as inventory levels fell by 121,000 cases. Lead analyst Ed Mahoney said the new system provides a standard 100-percent lot traceability by customer, within minutes.

INSTALLATION SIZE
The wireless system was initially installed in the Kenosha, Wis., warehouse and is now in the process of being installed at Ocean Spray's other manufacturing/warehousing locations around the country.

CORPORATE/SOHO

IMPLEMENT WIRELESS LAN TO
BOOST PRODUCTIVITY AND SAVE COSTS

Raylink offers a myriad of markets such as corporate or SOHO an affordable, comprehensive, and convenient solution for a variety of wireless local area network (WLAN) environments.

Leveraging Raytheon's leadership position in frequency hopping radio technology, Raylink products provide lower power consumption for users in comparison to similar direct sequence spread spectrum-based products. Aside from its impressive performance functionality, the products are also aggressively priced.

The Raylink solution, comprised of the Raylink Access Point, two Raylink PC, WISP PC Card, as well as a trio of adapters for ISA, PCI and USB connectivity, is a premium wireless LAN solution based on frequency hopping spread spectrum technology. The compelling products also offer impressive range, with network connectivity of up to 1,000 feet. Aside from Raylink's WLAN seires, WISP Series will network computers up to 5 miles (or mor) apart without one wire – a perfect solution for building-to-building networking.

APPLICATION: BRINGING WIRELESS TO THE CORPORATE/SOHO ENVIRONMENTS
Suited as a complementary solution to wired LAN infrastructures, the company's wireless products and solutions target a wide range of wireless LAN applications including: in-building roaming workers, temporary work groups, point-of-sale terminals, inventory management, and peer-to-peer networks. These applications are predominant in a number of horizontal industries such as corporate/business and small office/home office (SOHO).

BENEFITS: INCREASED PRODUCTIVITY AND SAVE COSTS

Wireless LANs help reduce overall comoputer and network costs, use space more efficiently and productively. Easily move stations. Count inventory. Input notes or numbers. Access internet under one IP address. Share files. Share printers, scanners and other peripherals. With Raylink wireless netwroking, everyone can bring no notebook to meetings, the warehouse or anywhere they need or want to work. Wireless networking not only increases communication between employees, it increases speed and productivity.

CAFÉ/GAMING ARCADE

WIRELESS LANS – THE FUN WAY TO ENJOY YOUR FAVORIATE COFFEE OR PLAY GAME

Customers at Café or gaming arcade now can enjoy an even better in-store experience, thanks to Raylink's wireless LANs products. For example, customers will be able to download the latest information on local arts and entertainment and shop online while enjoying their beverage at café or playing multi-player games on internet at gaming arcade. In addition, customers will be able to check their e-mail and even access corporate intranets to stay connected to the office.

BENEFITS: INCREASED TRAFFIC RATE AND STREAMLINED OPERATIONS & COMMUNICATIONS

Wireless LANs helps meeting the needs of customers by providing them with personalized and distinctive in-store experiences by providing high-speed wireless broadband Internet access.

Raylink wireless LAN solution will also boost productivity and save costs for company with multiple locations. The in-store network implementation will also update store technology to streamline operations and communications such as improved labor scheduling, planning and training, speeding up in-store ordering and payment among branch stores.

AIRPORT

WIRELESS INTERNET ACCESS THROUGH OUT THE ENTIRE AIRPORT

Raylink WLANs and WISP Series products is the perfect solution to provide broadband wireless Internet coverage throughout the entire airport. At the core of Raylink's progressive wireless solution are its unique array of products including the Raylink Access Point, PC Card, WISP Card, and trio of adapters for ISA, PCI and USB connectivity. The innovative products present end users with live network and Internet connectivity with an impressive range of up to five miles or more from the host LAN hub. Travelers can access internet or share files anywhere, anytime at the airport while they are waiting for the planes.

BENEFITS: INCREASED ACCESS TO INTERNET OR CORPORATE NETWORK WHILE WAITING TO BOARD THE PLANES.

Raylink's entire compliment of WLAN products utilizes the Frequency Hopping Spread Spectrum (FHSS) design technology. By implementing this system architecture, Raylink's products are more resistant to any outside interference from electromagnetic sources including appliances and other WLAN devices. The FHSS architecture provides additional immunity to interference jamming, unauthorized detection and noise than other WLAN systems integrating Direct Sequence Spread Spectrum (DSSS) technology. Millions of business travelers flying in and out of airports, with Raylink WLANs and WISP Series products, will be able to check their emails, download attachments, make last minute changes to their presentations, access their corporate LAN, or surf the Internet by simply turning on their laptops while they are waiting to board the plane.

WIRELESS ISPS

Raylink's WLAN and WISP Series products help ISPs (Internet Service Providers) create and design the wireless, broadband communications network for mobile professionals access to the Internet and their corporate intranet remotely. As the Internet develops into an integral part of business and personal life, demand for access has never been higher and shows no sign of slowing. Internet service providers face both incredible opportunities and challenges at the same time. Raylink's WLAN and WISP Series solve one of the most common challenges today - delivering high speed Internet access where no infrastructure exists. Numerous service providers can install Raylink WLAN and WISP Series to provide wirefree Internet connections; serving points of presence, off-ring multi-megabit last mile connections, and ultra-broadband campus extensions. Multiple access points can be collocated to increase service density and to enable roaming capabilities as well. A cost effective alternative to fiber or copper based facilities.

Benefit: Unplugged. Empowered. Accessible.

It's no longer sufficient to have Internet access at the office or at home. Increasingly, we expect Internet connectivity and secure access to our corporate network at public sites such as airports, train stations, hotels and convention centers. For service providers delivering public Internet access, Raylink offers a complete wireless networking solution. Our Raylink wirefree adapters and access points enable reliable, broadband Internet connectivity. Getting your high speed broadband Internet service to a home or business is just half the battle. Now, how do you distribute that connection to the users inside? Often, the best entry point is nowhere near your customer's computer. Or, there are multiple PCs in the home and the customer wants to have high speed Internet connectivity at all of them. Raylink WLAN and WISP Series are the answer. Speed up installation time, lower costs and give your customers the freedom to connect and share the Internet anywhere in their home or office.