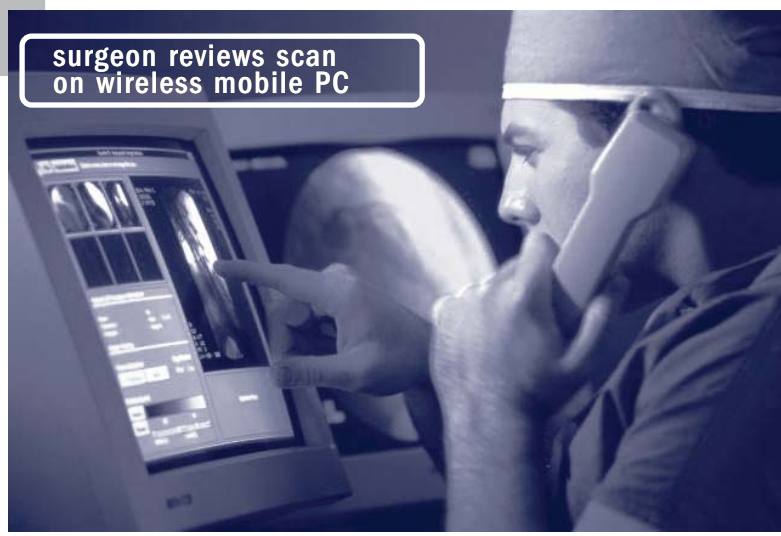
TRUE MOBILITY
IS A SHOT IN THE ARM FOR PATIENT CARE

Trapeze NETWORKS


surgeon reviews scan on wireless mobile PC

SAN ANTONIO COMMUNITY HOSPITAL
- Located in Upland, California
- 2000 staff members
- 400 physicians
- 350 beds
- 30,000 radiological images processed each month, average file size of 30-90 MB

MOBILE WIRELESS LAN APPLICATIONS
- PACS over Wireless
- Mobile PCs in ER and Surgery
- Voice over wireless IP phones
- PDAs with soft phones
- HIPAA-compliant medical record access
- PDA access to engineering work orders
- Tablet PC access to pharmacy and records

A surgeon reviews a brain scan on the wireless mobile PC a nurse has rolled next to the patient, a middle-aged man with a tumor in the anterior portion of his brain. The doctor tries to zoom in for a clearer view of the anterior cerebral artery, but the screen goes blank.

Like many IT professionals in health care organizations, Irv Hoff knows that network downtime – even minutes – can have serious consequences. That's why Hoff, Manager Converged Networks, and Jan Snyder, Senior Telecommunications Consultant at San Antonio Community Hospital in Upland, Calif., set out to create a radiology network with less than five minutes of downtime per year.

In designing this wired infrastructure, Snyder architected a fully redundant system. Each radiology subnet is based on a Layer 3 edge switch, which is dual-homed to two IP-routing-switches at the network core. If one core switch fails, the other takes over without any loss of x-ray data. As a result, the hospital has had zero downtime on its radiology network in more than three years.

When Snyder began piloting wireless networking 2 1/2 years ago, he knew that achieving comparable resiliency was going to be a challenge. And that challenge intensified as wireless network usage burgeoned among the 2,000 staff members, including 400 physicians, at this 350-bed independent hospital.

Initially, Snyder deployed wireless access points (AP) in the emergency room to streamline the collection of patient data. Using PCs on mobile carts linked via wireless networks to a database in IS, nurses can gather preliminary medical information as well as the data needed to admit a patient.

Soon after, San Antonio Community Hospital installed wireless APs in the hospital lobby in order to streamline admittance of waiting patients. Use of the wireless network quickly spread beyond administrative tasks to medical applications in both the emergency room (ER) and surgery.

Radiology is a specialty at San Antonio, which switched more than three years ago from X-ray film to all digital radiology imaging using the Picture Archive Communication System (PACS). The hospital currently processes 30,000 radiological images per month, with each file ranging from 30-90 MB in size.

With the wireless network and mobile PCs in ER, radiologists are able to display images of broken bones, for example, from portable x-ray machines. Initially deployed in the emergency room, this mobile imaging capability quickly caught the attention of surgeons who wanted to view a broad array of radiology images during surgery.

Consequently, Snyder deployed 802.11b APs in surgery. Relative to the film-based system, whereby surgeons clip individual radiology films to light boxes, the wireless system enables surgeons to view dozens of images during surgery and to manipulate those images – zooming in, for example – as needed.

Growing Pains

Unfortunately, first-generation wireless systems were prone to failure, had weak security, and didn't scale easily. Recognizing the tremendous benefits wireless could offer in improving the quality of patient care and streamlining hospital operations, Hoff and Snyder set out to find a second-generation wireless system that could match the reliability of the hospital's radiology network without overtaxing IS resources.

> "Total cost of ownership was the clincher, and the RingMaster software is the key to that," said Hoff. "And Trapeze follows the standards, it's not proprietary."

One of the earliest problems to surface with the first-generation installation is the so-called "bug light" problem. Snyder came to understand this problem well when one of the APs in surgery failed. Although the mobile PC picked up a signal and associated with the AP, no image was displayed. Snyder found that the AP's connection to the host computer was broken.

A second, nearby AP did not provide backup connection, as expected, because the mobile PC continued to "home in" on the stronger RF signal coming from the broken AP, much like a bug is drawn to a bright light. Snyder realized that installing redundant APs wouldn't solve the "bug light" problem unless the faulty radio could be easily isolated and turned off. Eliminating these faults became a priority in the hospital's search for a second-generation wireless system.

In addition to reliability issues, concern about the security of the first-generation wireless system increased as dependence on the network grew, compounded by the need to comply with Health Insurance Portability and Accountability Act (HIPAA) regulations regarding patient data privacy.

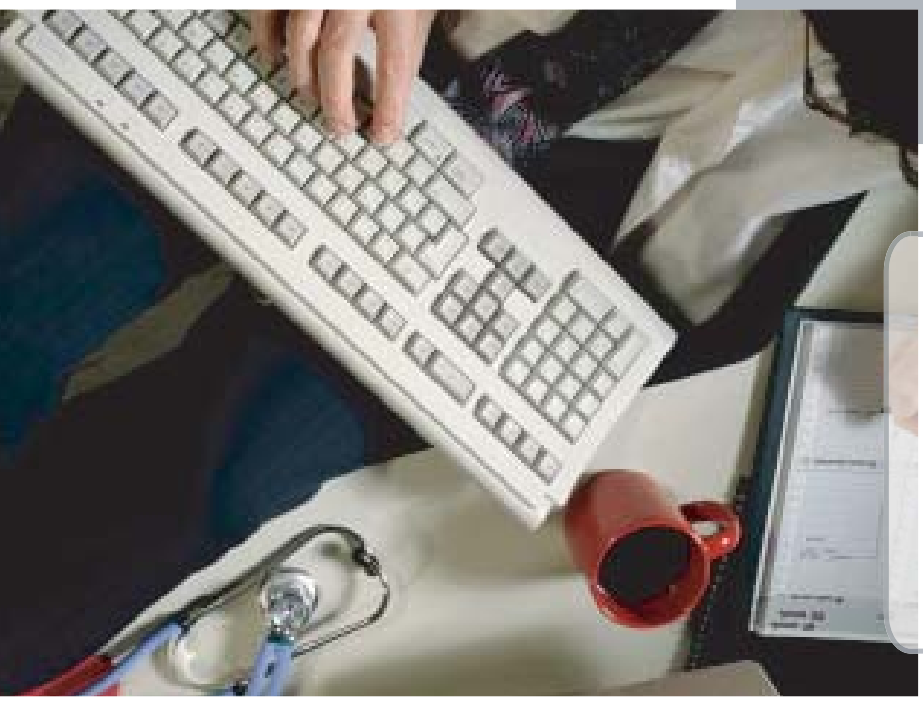
The first-generation system uses static Wired Equivalent Privacy (WEP) protocol for encryption, whereby static keys are shared among all users and APs. Although changing keys frequently would increase security, such a change requires rebooting every PC and every AP, an onerous task that's not practical in a hospital operating 24 x 7.

Likewise, the first-generation wireless system used Ethernet MAC addresses to limit user access. Adding a new PC and MAC address to the network entails reconfiguring – and rebooting – all the APs that might "see" that PC, adding to configuration and support overhead and network downtime.

In addition, the 802.11 Service Set Identifier (SSID) that isolates user traffic (for example, by department) is not secure. It can be easily copied, enabling a rogue user to tap into an unauthorized portion of the network.

Mobility is also negatively impacted by the lack of integration between the PACS Layer 3 network and the first-generation wireless system. Users are required to re-login each time they move to a new AP across PACS subnetworks. True roaming isn't feasible because connections are dropped as users move between APs on Layer 3 subnets. Many wireless systems can only support roaming across a flat, Layer 2 infrastructure.

The San Antonio Community Hospital IS team did not want two parallel



> "We found everything we want in a wireless system," Snyder said.

networks – Layer 2 for wireless and Layer 3 for PACS. Nor did they want to convert their Layer 3 infrastructure to Layer 2.

Looking ahead, Hoff could also see that the first-generation wireless system – with a high rate of radio failures and APs that need to be manually configured on an individual basis – wasn't scalable, particularly for an organization that could dedicate only two IS staff members to support it.

The Search Begins

Late in 2002, Hoff and Snyder began a search for a second-generation wireless system that could provide the features that San Antonio needed – reliability, security, mobility and scalability – at a price point that would fit within the hospital's budget. Smooth integration of a flat, Layer 2 wireless system with the reliable PACS Layer 3 radiology network was also important to Hoff.

Snyder quickly narrowed the search to five vendors, including his existing wired and wireless infrastructure vendors. He conducted a detailed comparison of product features as well as capital and operational costs. He also investigated the compatibility of his existing software and hardware with each wireless system, as well as weighed the viability of each company.

Based on this analysis, Hoff and Snyder selected Trapeze Networks as the hospital's second-generation wireless infrastructure provider. They began beta testing the Trapeze Mobility System in spring of 2003, with production deployment in the fall.

"Trapeze seemed to understand every problem we had and resolved all of them," Snyder noted.

Hoff was also won over by the ease of installation, configuration, and operation of the Trapeze system. Snyder estimates that Trapeze's planning and management tool, RingMaster, will save the non-profit San Antonio Community Hospital 70%-90% over other wireless systems in labor, operations, and support costs.

In addition, because the Trapeze Mobility System can be implemented as an overlay to an existing PACS network, it allows the hospital to leverage the reliability and resiliency of its Layer 3 infrastructure, while permitting users to roam across the Layer 2 wireless system.

Trapeze's seamless integration with the Layer 3 wired network meant no changes were needed in the hospital's routing switches, backbone configuration, or client configurations – eliminating time consuming and potentially error-prone network reconfigurations.

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Meeting the Challenge

Despite the demanding nature of a hospital environment, Snyder found that the Trapeze Mobility System meets – and often exceeds – each of the hospital's feature requirements.

A physician gets a quiet moment to upload notes

RELIABILITY – In seeking to match the reliability of his wired infrastructure, Snyder was impressed by the well thought-out redundancy and resiliency features designed into the Trapeze Mobility System. As a fully distributed system, there's no single point of failure.

Importantly for San Antonio, Trapeze's design eliminates the "bug light" problem. Each Trapeze Mobility Point (MP) has two 10/100BASE-TX Ethernet ports that can be dual-homed to two Mobility Exchange (MX) switches, providing redundancy for both data traffic and power over Ethernet (PoE).

Failure of a radio, data link, or any other component of an MP will result in traffic from that MP being handed off to another MP. For example, if the MX software detects that both the data links in an MP have failed, it will shut down power to that MP's radio, enabling mobile PCs to associate with a nearby radio. In addition, MXs that supply PoE have redundant, load-sharing, hot-swappable power supplies.

"We're a very slim operation here," Hoff noted, "We don't have time to fix broken radios."

Consequently, Snyder has taken full advantage of the redundancy features of the MP, pulling two cables to each access point to enable both power and data ports on each Trapeze MP. The cost of the extra cable was more than offset by the money RingMaster saved him in planning and configuring the installation.

MXs also can be dual-homed to the wired backbone. Uplink ports on the MX provide redundant, load-sharing links to the wired network, including 802.1Q trunking, features that simplify integration with the wired infrastructure as well as ensure that traffic will keep moving between wireless and wired resources in the event of a link failure.

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SECURITY – Tighter security was also high on San Antonio's requirements list.

"With HIPAA, we can't afford to have patient records out in the open," said Hoff.

Trapeze security starts with IEEE 802.1X, which provides strong encryption of all Layer 2 and Layer 3 information in the air between a PC and an MP. Unlike VPN-based security on wireless systems, 802.1X encrypts even the IP address, which is important to San Antonio Community Hospital security.

Hospital PC users are running Microsoft XP, which includes 802.1X authentication. No special client software is required. Mobile users begin a communications session with an MP using 802.1X. Then both the user device and the MP to which it's attempting to attach must exchange a digital certificate before the user provides their name and password. This step eliminates "man-in-the-middle" attacks.

Once this certificate exchange is complete, the MP passes the user's name and password information to an MX, which forwards it to a RADIUS AAA server for authentication and permission to access network resources. In San Antonio's installation, user authentication is also passed through to Microsoft Active Directory before the DHCP server issues the user an IP address.

Trapeze designed the MX to offload many tasks from RADIUS servers. For example, once the MX authenticates a user's identity, it obtains the user's profile – permissions and attributes such as VLAN/subnet membership, access control lists, and class of service – from the RADIUS authenticator, and stores that information locally.

The MX also becomes an authenticator and generates encryption keys locally, offloading this function from RADIUS servers. Trapeze supports several encryption standards, including dynamic WEP with rotating broadcast/multicast keys, the Temporal Key Integrity Protocol (TKIP) and the Advanced Encryption Standard (AES). San Antonio uses dynamic WEP at the present time.

Because of these security enhancements, the hospital's wireless

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network is now more secure than its wired infrastructure, according to the hospital's security engineer, who is now looking to implement 802.1X in the wired network. Another benefit of Trapeze's security architecture is that it enables roaming.

MOBILITY – By equipping physicians, nurses and caseworkers with 802.11b-enabled voice over wireless IP (VoWIP) phones and personal digital assistants (PDAs), San Antonio can support real-time communications between caseworkers and physicians, resulting in improved quality of patient care and streamlined hospital operations.

With the current "fixed" desk phone and paging system, physicians, nurses and caseworkers lose valuable time because of missed calls and waiting for callbacks. Quicker access to physicians will allow nurses to move patients from critical care to ambulatory care in anticipation of discharge, freeing up needed beds for incoming patients from ER. With improved efficiencies, the hospital anticipates that patient-to-nurse ratios will increase 25%-30%.

Key to these productivity gains is the ability for the wireless network to seamlessly hand off a communications session from an MP in one PACS subnet to another as a user roams. The Trapeze Mobility System supports roaming through its distributed architecture. MXs exchange user information so that a user's permissions and access rights follow users as they roam.

Users can move from MP to MP and subnet to subnet across the San Antonio PACS radiology network without being required to login at each hand-off point. This seamless hand-off also makes voice communication over the wireless infrastructure possible, a capability that the hospital is eager to exploit.

SCALABILITY – Hoff knew that installation, operations and management overhead could easily make an expanded wireless system too expensive to deploy. Snyder initially considered using the hospital's existing wireless site survey and building out the first-generation wireless system.

However, IS quickly realized that the site plan was obsolete – walls had been moved, for example, and maternity had since installed lead-shielded walls. San Antonio Community Hospital was facing a potentially costly planning process for its next-generation wireless system.

In addition, Snyder knew that organizations with large-scale wireless installations required large support crews to keep the network running. Microsoft, for example, reported one service call per 40 APs per day – an untenable support load for the hospital.

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When Trapeze briefed Hoff about RingMaster, its planning, configuration, and management tool, his first reaction was "this is too good to be true." However, after using RingMaster to plan and deploy his test system, and then San Antonio's production network in the ER, Hoff said, "One by one, we've confirmed every promise – Trapeze RingMaster really works."

Hospital Network Engineer Kent Pham imported an AutoCAD file of the facility's layout into RingMaster, entered information about wall composition and created a site plan indicating where to deploy MPs. The process took hours rather than the weeks needed for a manual site survey.

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RingMaster also automates configuration of the Mobility System, assigning power levels and RF channels to each MP. If a new MP is added later, for example, RingMaster automatically recalculates channel assignments and power levels, adjusting neighboring MPs accordingly.

Another benefit for San Antonio was that RingMaster generates a work order that shows exactly where to install MPs. Snyder gave the work order to a contractor who not only pulled the cable but plugged in the MPs as well. This "plug and play" is possible because each radio receives PoE and automatically downloads its configuration from the MX and RingMaster.

"With the Trapeze system, installing or swapping out a radio is as easy as changing a light bulb," said Snyder.

The Trapeze Mobility System also scales in terms of data speed by supporting 802.11b and 802.11a in the same radio. As a result, San Antonio Community Hospital can implement 802.11a as needed, enabling a radiologist to download 156 CAT scan images in seconds.

Hitting the Numbers

In evaluating capital and operational costs, the Trapeze Mobility System was a fraction of the cost of the other wireless systems Snyder evaluated.

Although hardware costs were similar among the vendors that were evaluated, a major savings emerged in installation, operation and support costs.

For example, the hospital saved money on the installation because the cabling contractor was able to install the Trapeze radios; with other vendors' systems, Snyder would have needed a skilled technician to configure each radio.

RingMaster's site planning capabilities eliminated the need for a costly site plan, while its configuration tools drastically reduced the amount of time required to configure individual APs.

Snyder noted that when he combined capital and operating costs for the first year, the Trapeze Mobility System was two-thirds the cost of other vendors' wireless systems. Over five years, the Trapeze system is half the cost of other systems.

San Antonio expects to realize a return on its Trapeze wireless LAN investment in less than one year because of productivity gains, such as streamlining patient care and increasing patient-nurse ratios. Hoff also expects to realize IS operational savings.

Ready for Expansion

Not only is the Trapeze Mobility System enhancing existing wireless applications at San Antonio, it's opening up possibilities for innovative technology uses that the hospital never thought possible, said Hoff.

With a reliable wireless infrastructure in place, hospital administrators are now able to access management information from conference rooms and other meeting locations. Engineering personnel, who are scattered across the hospital campus, can also leverage the wireless LAN to get work orders via PDAs.

And with a new phone switch on order, Snyder is looking forward to equipping nurses with voice-activated "necklace"-style hands-free wireless phones and doctors with either wireless phones or PDAs with soft phones. This will allow them to communicate at any time from anywhere in the hospital.

Snyder is also evaluating wireless tablet PCs, which doctors could easily carry instead of a clipboard and use to review and amend patient files, fill out prescriptions (with the doctor's handwriting being converted to printed text), and other care-related applications.

In addition, Hoff and Snyder are looking at other wireless opportunities, including supporting guest network access and offering "hot spots" in the hospital lobby as well as patient access to the Internet.

San Antonio Community Hospital's management takes pride in using technology to give the best care possible to their patients. The Trapeze wireless LAN Mobility System is helping them do that.

Trapeze NETWORKS

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