IT@Intel Brief

Intel Information Technology

WLAN Design

June 2006

Wireless LAN as the Primary Network

Intel IT's vision for a truly mobile workforce inspired a groundbreaking technology transition to a unified network architecture in which wireless becomes the primary network access method for data, voice, and video.

We are deploying this primary wireless infrastructure at one of our large 5,000+ user campuses. Early results show that the wireless LAN (WLAN) is capable of supporting all our planned business applications. Users find performance comparable to the wired LAN when using common office applications and actually prefer using the WLAN overall.

We expect substantial cost savings due to a simplified infrastructure as we move to a more intelligently managed architecture.

Profile: Primary Wireless

- Integrated architecture for data, voice, and video
- Application performance comparable to wired LAN
- Deployment across 5,000+ user campus
- Expected savings of up to 21% on new infrastructure

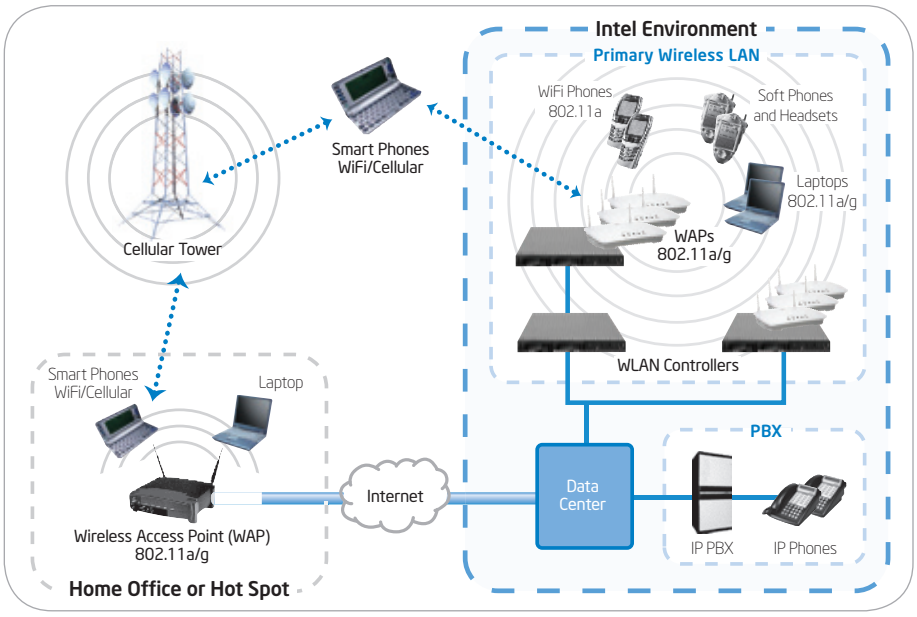

Figure 1. Our primary wireless architecture.

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Wireless Strategy

Establishing wireless as the primary network access method for business software applications, voice over IP (VoIP), and multicast video within one of our large campuses is a major change in direction for Intel's network architecture.

Until recently, we deployed wireless LANs based on 10-Mbps 802.11b, which are in high demand among our 70,000 mobile users. However, because they are slower-performing than wired LANs, our employees typically use them as a secondary access method. We also use a virtual private network (VPN) for WLAN security, which further hinders performance and increases operational costs. Additionally, having to maintain separate LAN, WLAN, and phone infrastructures is becoming increasingly expensive.

To provide an infrastructure capable of supporting primary wireless, we are designing a new architecture that integrates wireless and wired LANs (see Figure 1), providing wireless performance comparable to the wired LAN, eliminating excess infrastructure, and reducing cost. We plan to greatly reduce the number of wired LAN and phone ports, replacing them with 802.11a wireless connections.

We are increasing the density of access points to improve coverage and extend network capacity and performance. The 802.11a standard provides a nominal 54 Mbps of bandwidth, which decreases with distance from the access point. We have designed the network to provide a minimum of 36 Mbps per access point, shared between 12 to 22 simultaneous connections, with a goal of providing each user at least 5 Mbps bandwidth 90 percent of the time.

We are using technology based on emerging standards to make network access faster and easier. We have applied IEEE WiFi standards (such as 802.11i and 802.1x) to secure and automatically connect users, eliminating the need for a VPN. We are using 802.11e Quality of Service (QoS) to deliver a better voice experience to the user and secure roaming for wireless VoIP to ensure that users have uninterrupted service as they move about the campus.

Current Development

Over the past 18 months, we developed and installed a campus-wide design spanning five buildings housing more than 5,000 users. The self-healing network provides campus-wide resilience, automatically restoring service in the event of a failure in part of the infrastructure.

We are supporting users across the campus, supplying them with 802.11a-enabled notebook computers based on Intel® Centrino® mobile technology. This will provide us with a large user base to validate and fine-tune our architecture.

To evaluate the network design, we conducted studies of network utilization and performance characterization of typical office applications, such as e-mail and calendaring, file and print services, and Web access.

Results

During normal use of office applications, user bandwidth consumption was considerably below

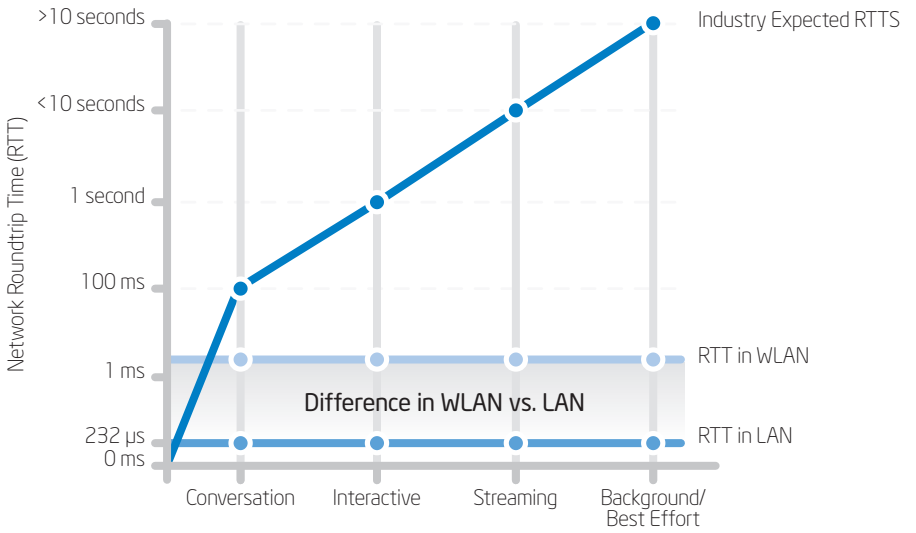

Figure 2. Network performance compared with industry expectations. Wireless and wired LAN response times are well under expected industry response times for various types of applications.

the overall capacity of the WLAN, indicating that the network is capable of supporting these and other planned applications. From a user perspective, performance of the WLAN was indistinguishable from the wired LAN, and overall, users preferred the WLAN to the wired network.

Users' perception of performance is closely related to the type of application they are using, and this is reflected in the differing industry expectations of acceptable network delay for voice, video, and typical business applications. Although the primary wireless network was slower than the wired LAN, the difference was below the threshold at which users begin to notice delays for any of these applications, as shown in Figure 2.

Analysis of network traffic showed that users used the same mix of typical office applications on the wireless LAN as on the wired LAN and used them to a similar extent, as shown in Figure 3.

During use of these applications, user consumption of wireless bandwidth remained well within our design goals. Average per-user bandwidth use varied from about 0.25 Mbps for Web access to 1.1 Mbps for real-time collaborative applications. In all cases, bandwidth consumption was much less than the available capacity, confirming that primary wireless is capable of delivering the bandwidth that our users require.

The network performance and other improvements resulted in high user satisfaction ratings in response

Relative Application Use in One-Month Period

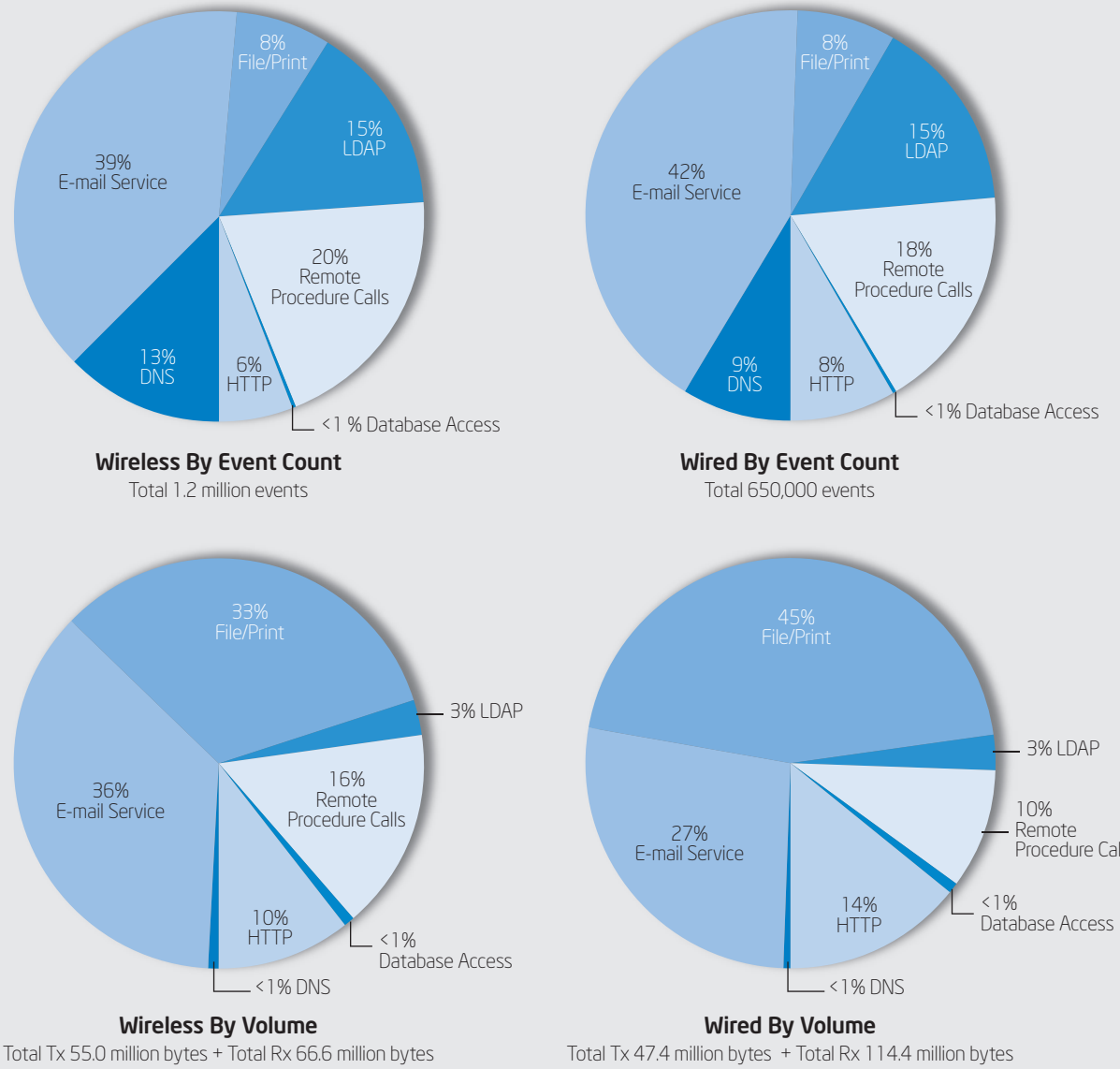

Figure 3. Use of applications on wireless and wired LANs. We see employees successfully using the same applications on both wired and wireless LANs. However, we see increased use of the network on wireless LANs as users take their notebooks with them.

to surveys. Users rated the wireless LAN comparable to the wired LAN or better in several key areas, as shown in Figure 4. When employees were asked which they preferred, they expressed a preference for the wireless network overall, saying it was easier to use. Because of this, they generally preferred to use the WLAN rather than the wired LAN wherever they could—even, in many cases, when at their desks, as shown in Figure 4.

Users gave the WLAN high points for ease and speed of network connection. Our previous WLANs used a VPN, which required an additional network logon step and impacted performance; users liked the fact that the new WLAN connected them more quickly and automatically through 802.1x authentication.

We also received many comments from users that indicated they were taking advantage of the improved wireless network to change the way they worked. Faster connection time made a big difference in conference room meetings where users wanted to quickly get online to access information or send e-mail. As a result, users said they were more likely to take their notebooks with them and connect from different locations throughout the day.

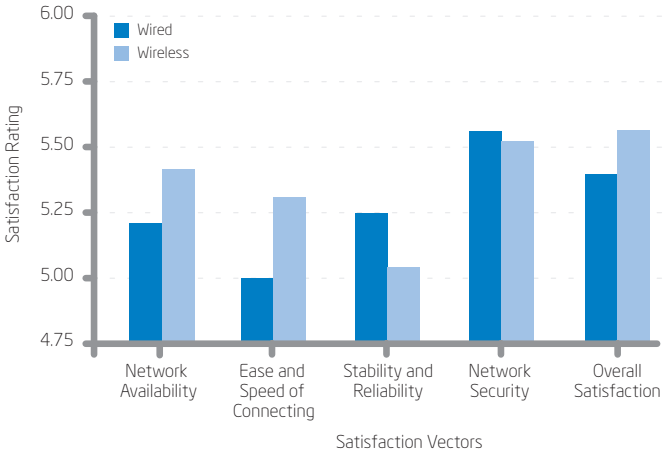

Figure 4. User satisfaction comparing WLAN with wired LAN

Estimated Cost Benefits

As we move to our new architecture throughout the enterprise, we expect financial benefits due to a lower cost of network infrastructure.

Currently, we run an average of 2.5 ports to each employee's workspace: one LAN and one phone port, with additional ports for redundancy. As we move to the new infrastructure, we anticipate progressively reducing the number of ports per user from 2.5 ports, to 1 port, to 0.5 port, to 0.25 port per user in new buildings we construct over time. By calculating potential savings in equipment, cabling, maintenance, and other infrastructure costs, we estimate saving between 9 and 21 percent when deploying network infrastructure in new buildings, with greater savings as building size increases. Figure 5 shows projected costs for a large building.

Future Plans

Our results to date show that our new primary wireless network architecture can support the planned applications at the level of performance that our users require. Our users value the wireless network and enhanced mobility, and we expect to start transitioning the enterprise to the new architecture over the next year.

As we begin to widely support other applications such as VoIP on handsets and dual mode devices, we will build in enhancements such as a more standards-based roaming, security, and QoS profile. We will describe these in future papers as our architecture evolves and is deployed.

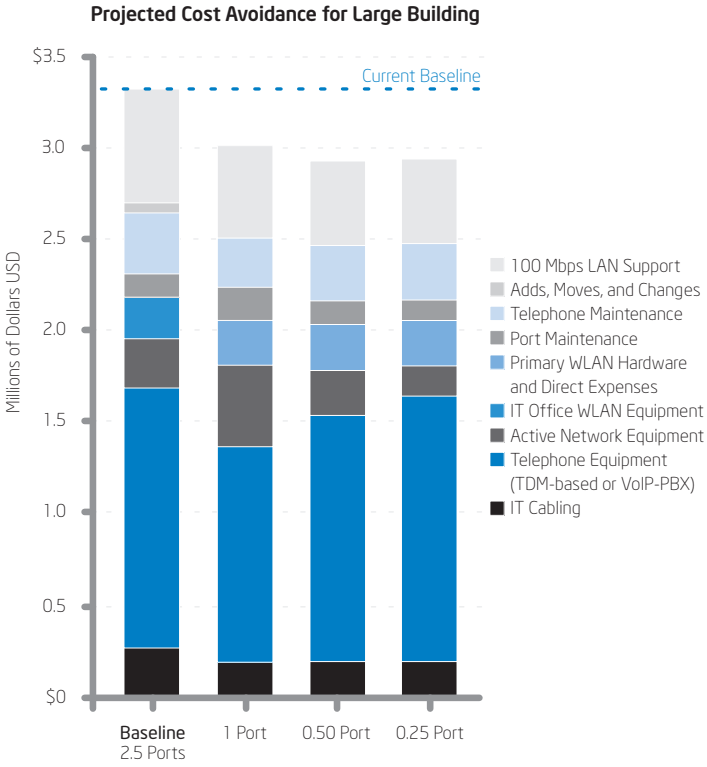

Figure 5. Estimated infrastructure cost avoidance due to primary wireless. We expect infrastructure costs to decrease as we build new buildings with progressively increased primary wireless capability.

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