

Wireless LAN Technologies: A Model for Planning, Designing, and
Implementing in a Global Manufacturing Enterprise

by

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A dissertation idea paper submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy

The Graduate School of Computer and Information Sciences
Nova Southeastern University

December 2001

Chapter I

Introduction

Wireless local area networks (WLANs) have the potential to improve the flexibility, productivity, and the quality of work life of an enterprise (Sage Research Staff, 2001). American Axle and Manufacturing (AAM) is typical of a large manufacturing company. AAM is a tier one supplier of automotive driveline systems headquartered in Detroit, Michigan (AAM, 2001). AAM specializes in the design, engineering, validation, and manufacture of driveline systems, chassis systems, and forged products for trucks, buses, sport utility vehicles, and passenger cars. The company is a global enterprise with 12,000 employees and seven million square feet of manufacturing space in 17 manufacturing facilities located in the United States, Brazil, Mexico, and the United Kingdom.

AAM's existing network infrastructure is wireline. Employees at AAM locations worldwide connect to the AAM network using wired ports connected to a fiber optic backbone. Remote users access the network through a dial-up modem pool. AAM's wireline network model severely limits the accessibility and effectiveness of the AAM network. For example, employees in AAM facilities are unable to access the network easily from meetings, the cafeteria, or anywhere other than their offices. In addition, the effectiveness of remote users is limited by the slow speed of present-day dial-up modem connections.

The following introductory sections describe the problem to be investigated and the goal to be achieved. The introduction also provides an analysis of the relevance and

significance of the research and a discussion of barriers and issues related to achieving the goal. In addition, the approach and resources to be used in accomplishing the goal are discussed. Finally, a brief summary is provided.

Problem Statement and Goal

The proposed research will address a problem confronting many large manufacturing companies in the present-day (i.e. how to best plan, design, and implement WLAN technologies). While WLAN technologies offer the benefits of mobility, reduced installation time, and decreased cost, many challenges must be met by companies deploying them (Geier, 2001). These issues are related to security, speed, interoperability, equipment selection, ease of use, reliability, signal interference, installation, and health risks.

In addressing the problem, the proposed research will use the case study method to examine the plan, design, and implementation of WLAN technologies at AAM. At present, the wireline local area network (LAN) technologies employed by AAM include 10/100BaseT Ethernet at each desktop. Ethernet ports at the desktop are switch connected to an Asynchronous Transfer Mode (ATM) fiber optic backbone. AAM's remote facilities connect to the network using switched Frame Relay services along with Internet Virtual Private Network (VPN) connections.

These technologies are of limited effectiveness in connecting employees while at work and at home to the AAM network. AAM's wireline infrastructure does not allow employees on the move to leverage the time they spend at meetings, in the cafeteria, and other locations to catch up on e-mail, retrieve information, or perform other work related

activities (Sage Research Staff, 2001). For example, the way Microsoft employees interact at work was dramatically affected by the company's installation of IEEE 802.11b WLANs (Orenstein, 2001). Microsoft employees no longer attend virtual meetings using desktop videoconferencing. Instead, they go to real meetings and bring their offices with them (i.e. laptops with WLAN connectivity).

In addition, the cost and time required to install and operate wireline networks in large manufacturing facilities to support industrial automation is often excessive. For example, the total cost of ownership (TCO) for a WLAN in the typical small office is 15 percent lower than the TCO for a wired LAN (Blackwell, 2001). The spread between wired and wireless LAN TCO is likely to be greater for LANs installed in large manufacturing facilities. These plant-floor LANs are common in AAM's facilities and are comprised of thousands of feet of cable. This cabling connects a variety of industrial automation controllers together and facilitates system control and data acquisition (SCADA) along with control program uploads and downloads. Wireless LAN technologies would seem to be more appropriate in this environment since plant-floor LAN cabling is frequently removed or relocated in reaction to changing manufacturing process requirements.

The limitations of wireline networks also extend into AAM employee residences. Remote users connect to the AAM network using dial-up connections with a maximum data rate of 56 kilobits per second (Kbps) downstream and 33.6 Kbps upstream. This remote access solution does not provide telecommuters and other less frequent work-at-home users the benefits of untethered high speed access to corporate applications from small home/home office (SOHO) venues.

The goal of this research is to provide large manufacturing enterprises a model for deploying secure WLAN technologies in their offices, manufacturing facilities, and employee residences. The model will be developed from a case study of WLAN projects to be implemented at AAM. While companies such as Intel were quick to embrace WLAN technologies and applied a strategic rather than a tactical approach to their deployments (Staff, 2001). Many other companies including Allina Health System reconsidered planned wireless initiatives in light of security inadequacies, changing standards, and equipment interoperability issues. Allina originally planned a full-scale implementation of WLAN technologies throughout its medical facilities. However, security issues forced the company to reconsider the plan. WLAN suppliers now emphasize that the implementation of wireless technologies must be part of an overall wireless strategy (MSI Editors, 2001). The WLAN implementation model that will be developed will benefit large-sized manufacturing companies.

In addition to the model, this research will provide a template of a comprehensive wireless security policy for use by manufacturers. This policy will address the proper use of corporate wireless networks in addition to the existence of user configured wireless networks.

Relevance and Significance

WLANs are beginning to replace traditional wired LANs as the preferred approach to the “last ten feet” of enterprise network environments (Hannon, 2001). In fact, more than 50 percent of companies have plans to purchase and install WLAN

systems. The release of high data rate and Ethernet-equivalent WLAN technologies is primarily responsible for this trend (Intel Staff, 2001). Low cost, high speed, interoperable products provide companies the flexibility to wirelessly transfer large data files, access the Internet, support wireless videoconferencing, and rapidly reconfigure sites.

Existing WLAN technologies include infrared, ultra high frequency (UHF) narrowband, and spread-spectrum (Garg, 2001). Most WLAN systems use spread-spectrum, which is a wideband radio frequency (RF) technique that uses the entire allotted spectrum in a shared manner as opposed to dividing it into discrete pieces as with UHF narrowband (Garg, 2001). The IEEE 802.11 family of standards, which are based on Ethernet technology, employ spread-spectrum solutions.

The four IEEE 802.11 standards that exist at present are 802.11, 802.11a, 802.11b, and the recently approved 802.11g (Krazit, 2001). IEEE 802.11 provides 1 or 2 megabits per second (Mbps) transmission in the 2.4 Gigahertz (GHz) band using either a frequency-hopping spread-spectrum modulation (FHSS) technique or direct-sequence spread-spectrum (DSSS). IEEE 802.11b defines an 11 Mbps data rate in the 2.4 GHz band, IEEE 802.11a defines a 24 Mbps data rate in the 5 GHz band, and 802.11g defines a data rate of 54 Mbps in the 2.4 GHz band.

In addition, Bluetooth, a short-range wireless standard, provides up to 720 Kbps data transfer in 2.4 GHz band. Companies deploying these high rate WLAN technologies must be aware of possible interference between IEEE 802.11, Bluetooth, and other 2.4 GHz devices sharing the same bandwidth (Brewin, 2001). WLANs that employ the 802.11b standard are the most prevalent. Examples include networks at hospitals and

university campuses along with retail stores and warehouses (Wheat, Hiser, Tucker, Neely, & McCullough, 2001).

WLAN technologies offer large manufacturing companies the ability to enable wireless mobility throughout a facility. WLANs also facilitate the addition or relocation of workstations and the connection of users in areas where the installation of a wireline network is difficult (Intel Staff, 2001). However, as widespread deployment of WLAN technologies continues, companies must ensure that their wireless networks integrate with their wireline infrastructure to form a seamless entity.

This model for the deployment of WLAN technologies, which is the goal of the research, is valuable because it will benefit large manufacturing companies as they continue the installation of WLANs. Network design engineers have struggled for years to streamline the design and implementation process (Wheat et al., 2001). WLAN technologies have further complicated this process. This research will contribute to the body of knowledge and improve professional practice by providing a modern life cycle model to plan, analyze, design, implement, and support enterprise wireless initiatives based upon real life lessons learned from a case study of AAM's WLAN projects (Whitten, Bentley, & Dittman, 2000).

The planning phase of the model will seek to identify and prioritize wireless technologies and applications that will provide the greatest return on investment to a large manufacturing company (Whitten, Bentley, & Dittman, 2000). Activities performed in this phase include specifying the business mission, defining an information architecture, and evaluating business areas. The second or analysis phase of the model will study current company networks and define the user requirements and priorities for

the WLAN. This phase is made up of three basic activities: surveying project feasibility, analyzing current infrastructures, and defining and prioritizing user requirements.

The systems design or third phase of the process will be an evaluation of alternative solutions and the specification of a detailed WLAN solution (Whitten, Bentley, & Dittman, 2000). This will be followed by the implementation phase, which entails the construction of the wireless network and the delivery of a working system into day-to-day operation. The final phase of this SDLC process will be the systems support or ongoing maintenance of the WLAN. This includes both maintenance and improvements.

Barriers and Issues

The goal of this research is difficult and has not already been met for a number of reasons. One explanation is the complexity of planning, designing, and implementing WLAN technologies in a large manufacturing company. Underlying issues include limited access to worldwide facilities, information technology resources, and network infrastructure, along with the security weaknesses inherent in the existing Wired Equivalent Privacy (WEP) algorithm (Fluhrer, Mantin, & Shamir, 2001). An additional issue is the need to integrate properly new WLAN technologies with existing wireline infrastructures. The resultant mixed-mode wireless and wired configuration should operate more efficiently than the previous single-mode environment.

Another issue is the emergence of competitive IEEE WLAN standards: 802.11b, 802.11a, and 802.11g (Curl, 2001). In addition, different countries and organizations are promoting their own WLAN protocols such as HiperLAN-1 and HiperLAN-2 (Bourin,

2001). Enterprises considering WLAN technologies must determine which available or emerging technology is the best fit based upon project timing, equipment compatibility, equipment availability, and their existing network topology (MSI Editors, 2001).

Companies must be careful to implement wireless applications as part of an overall wireless strategy and not just as isolated solutions.

Approach

The Modern System Development Lifecycle (MSDLC) method consists of five phases: planning, analysis, design, implementation, and support (Whitten, Bentley, & Dittman, 2000). This method will be employed to implement four WLAN initiatives at AAM. These wireless projects will serve as the subject of the case study, which is a key element of this research. The AAM WLAN projects are briefly described as follows:

Wireless Connectivity in Executive Conference Rooms - Worldwide

The scope of this project will include the evaluation, selection, and implementation of 25 IEEE 802.11b wireless access points at 12 locations worldwide with 70 wireless users. These locations will be Detroit Corporate Headquarters, Detroit Gear and Axle Plant, Detroit Forge Plant, Three Rivers Driveline Plant, MSP Industries, Tech Center, Global Procurement Center, Colfor Manufacturing, Buffalo Gear and Axle Plant, Tonawanda Forge Plant, AAM de Mexico, and Albion Automotive. Once installed, WLAN access at these locations will provide the AAM executive staff with the ability to access seamlessly key management applications while they are out of the office reviewing remote plant operations. These applications will include e-mail, calendar, Factory Information System (FIS), and Enterprise Resource Planning (ERP).

AAM@Home – Elite

The scope of AAM@Home – Elite will include the evaluation, selection, and implementation of a wireless solution to be used by AAM executives and remote users to access corporate applications while wirelessly connected at home to high speed broadband Internet connections. Integral to the project will be the installation of broadband cable Internet connections along with WLANs in the homes of ten users. Six of these users will be Information Technology Department managers and four will be AAM vice presidents. In addition, a VPN (Virtual Private Network) server and Terminal Services (TS) server will be installed on the AAM wireline network to allow users fast, secure access from the Internet to commonly used AAM applications. These applications will include Microsoft Office Pro, Microsoft Project, Microsoft Outlook, Microsoft Publisher, Microsoft Visio, Oracle Enterprise Resource Planning (ERP), and the AAM Portal.

Enhanced Wireless LAN Security

The scope of this project will include the evaluation, selection, and implementation of an enhanced wireless security solution for the AAM enterprise. This additional layer of security will offset recently discovered weaknesses in the IEEE 802.11b WEP security protocol (Borisov, Goldberg, & Wagner, 2001). The use of the WEP algorithm is not considered an adequate long term WLAN security solution for large enterprises such as AAM (Reynolds, 2001). Solutions that will be evaluated during the implementation of this project include a combination of VLAN (Virtual Local Area Network) and VPN technologies, ReefEdge Mobile VLAN, WEP Plus, and other proprietary solutions from a host of wireless equipment manufacturers. In addition, the

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| 3. Complete systems analysis phase | February 1, 2002 |
| 4. Complete systems design phase | March 1, 2002 |
| 5. Submit dissertation preliminary proposal | April 3, 2002 |
| 6. Complete systems implementation phase | July 31, 2002 |
| 7. Complete systems support phase | August 31, 2002 |
| 8. Submit dissertation formal proposal | September 15, 2002 |
| 9. Submit final dissertation report | March 9, 2003 |

Resources

The resources required to conduct this research include the following:

- Approval by AAM to conduct the case study in AAM facilities worldwide
- Funding by AAM to purchase all required hardware and software
- Assignment of select members of the AAM Information Technology staff to implement the WLAN projects discussed above
- Assignment of this researcher, AAM Senior Technology Manager, to act as project manager for the WLAN projects

The Executive Director of Information Technology/Chief Information Officer (CIO) of AAM has approved all of the above.

Summary

Companies purchasing wireless LAN technologies during 2001 surpassed analysts' expectations (Bassuener, 2001). In fact, the WLAN market is expected to grow from 3.3 million units in 2000 to 23.6 million in 2005. WLAN technologies provide

companies with many competitive advantages when properly leveraged. In the above sections, this idea paper describes the problem to be investigated and the goal to be achieved. The problem is how large manufacturing enterprises are best able to plan, design, and implement WLAN technologies. The goal is to provide a model for those companies deploying WLAN technologies in their offices, manufacturing facilities, and employee residences. This investigation also provides an analysis of the relevance and significance of the research along with a discussion of barriers and issues related to achieving the goal. In addition, the approach and resources to be used in accomplishing the goal are discussed.

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