

# Guide to Networking Essentials Fifth Edition

## *Chapter 4* *Network Interface Cards*

# Objectives

- Describe a network interface card's function and configurable options
- List important factors for selecting network adapters
- Describe types of special-purpose network interface cards
- Explain the role of driver software in network adapters

# Network Interface Cards (NIC) Basics

- For any computer, a **network interface card (NIC)** performs two crucial tasks
  - Establishes and manages the computer's network connection
  - Translates digital computer data into signals (appropriate for the networking medium) for outgoing messages, and translates signals into digital computer data for incoming messages
- NIC establishes a link between a computer and a network, and then manages that link

# From Parallel to Serial and Vice Versa

- NICs also manage transformations in network data's form
  - The **computer bus** has series of parallel data lines
    - **Parallel transmission**
- For nearly all forms of networking media, signals traversing the media consist of a linear sequence of information that corresponds to a linear sequence of bits of data (**serial transmission**)
- To redistribute serial data to parallel lines (and vice versa), one of the most important components on a NIC is memory, which acts as a **buffer**

# From Parallel to Serial and Vice Versa (continued)

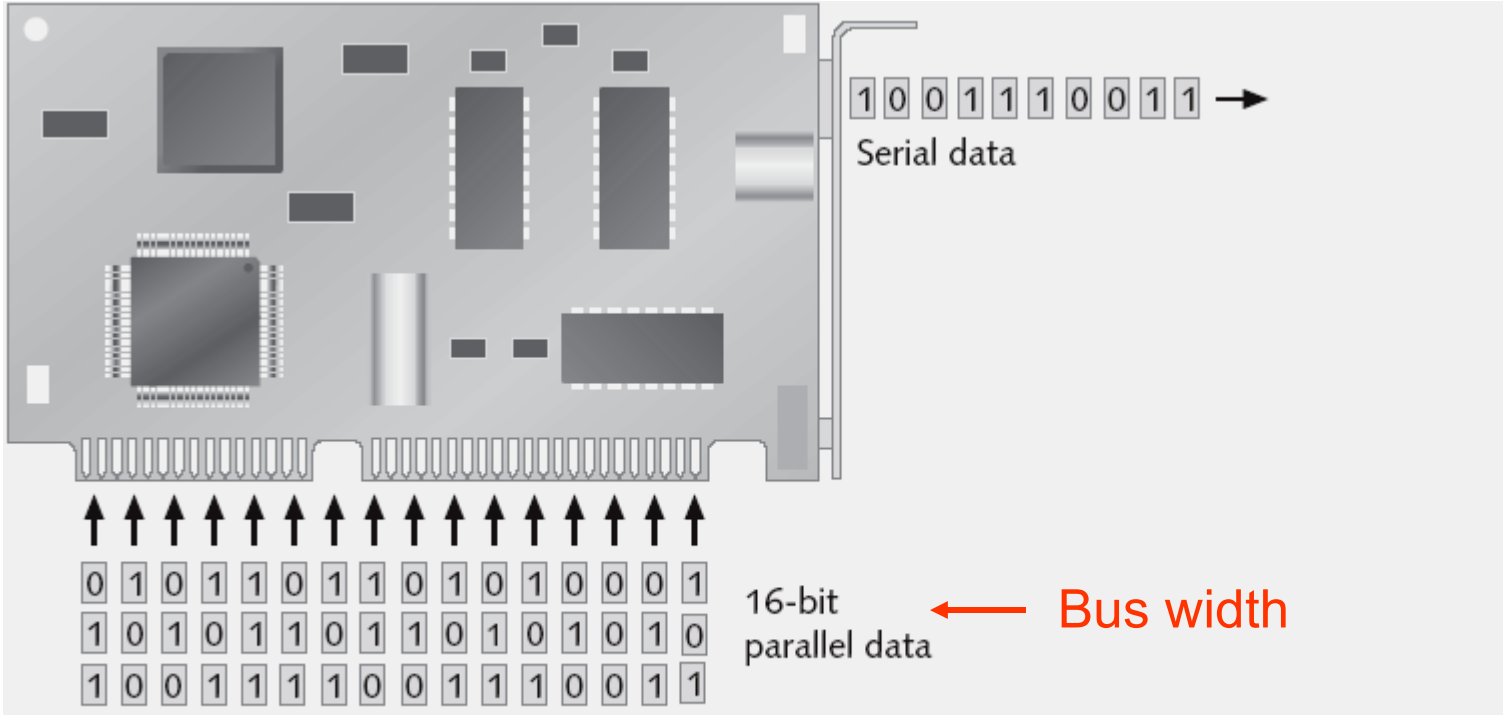
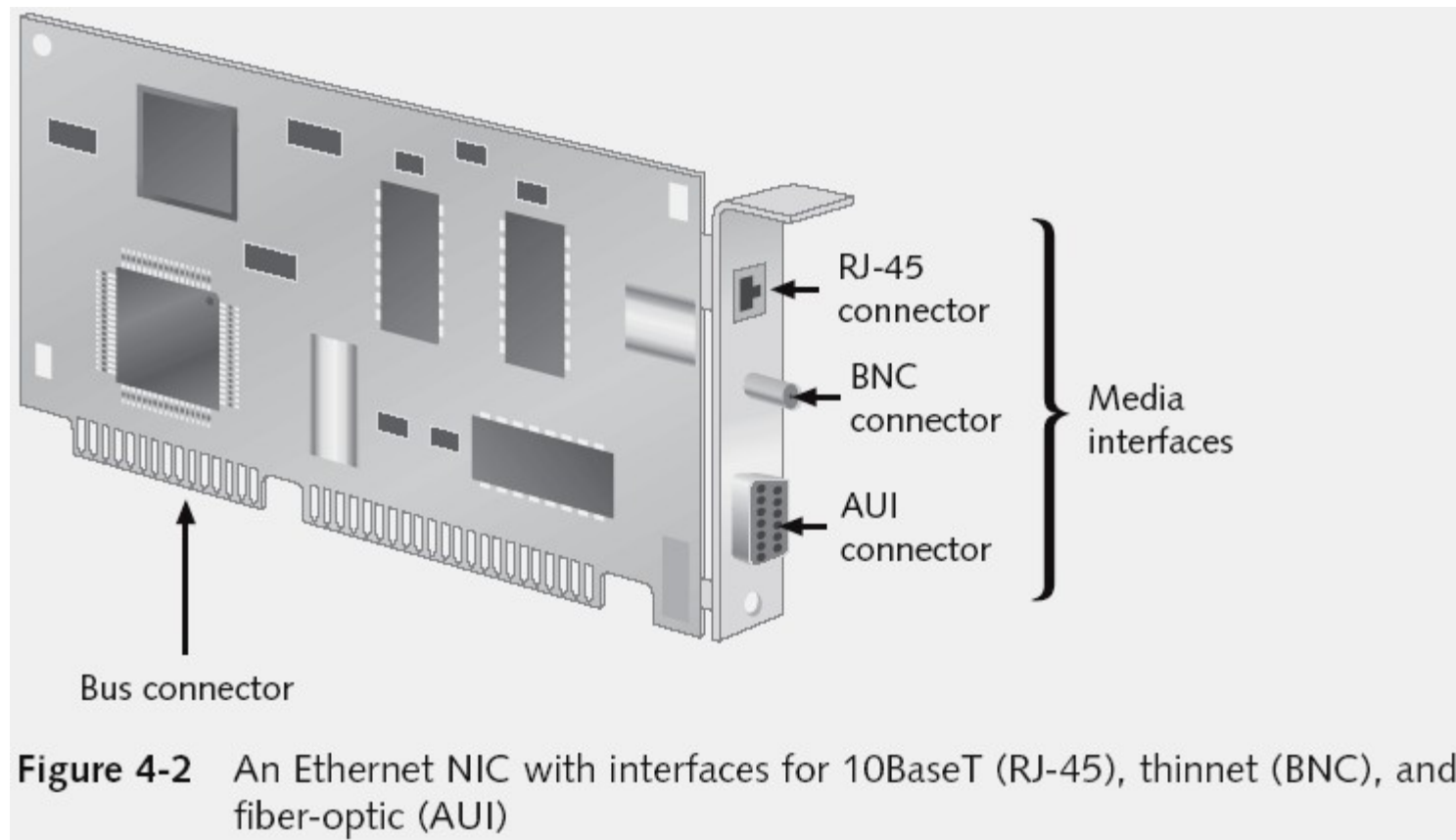


Figure 4-1 NICs mediate communication between a computer and the network cable

# From Parallel to Serial and Vice Versa (continued)



# Additional Functions of a NIC

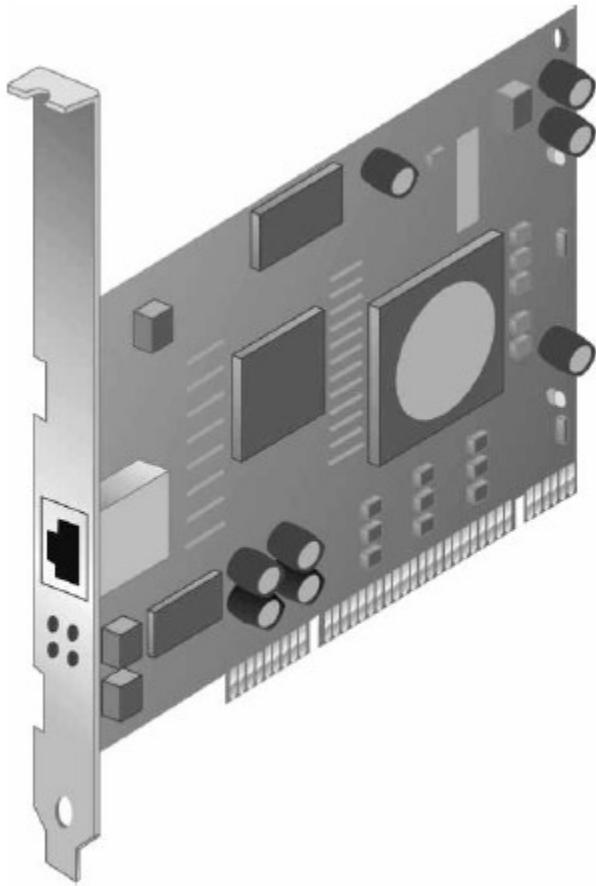
- Creates, sends, and receives frames
  - Frame: fundamental unit of data for network transmission and reception
- Deals with frame-level errors and incomplete or unintelligible frame structures
- Manages access to medium
- Acts as gatekeeper (permits inbound communications aimed only at its computer (or broadcast) to pass through NIC and on to CPU)
  - Each card has a unique **MAC** address in ROM
  - Promiscuous mode disables gatekeeper functions

# PC Buses

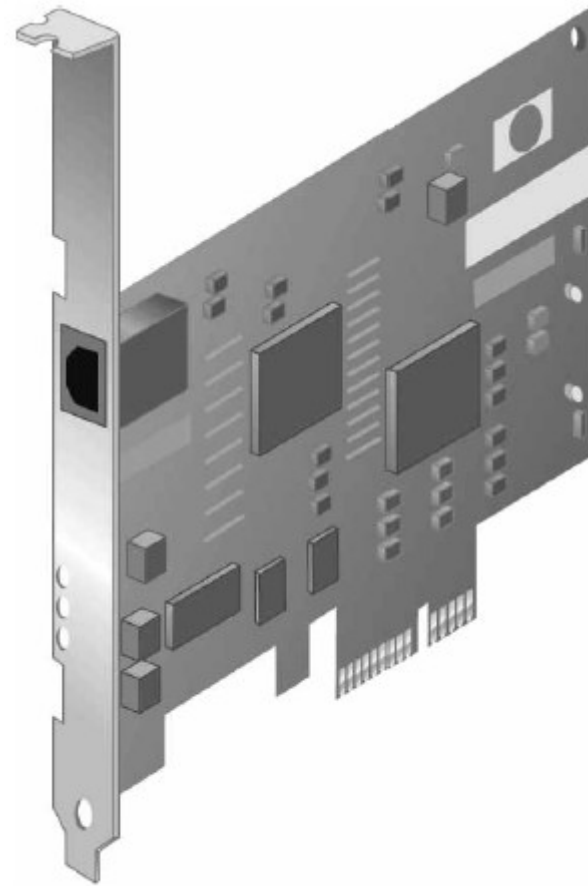
- When PCs were introduced, only a single bus design existed: a limited 8-bit bus
- As technology evolved, other buses came along
  - Peripheral Component Interconnect (PCI)
  - PCI-X
  - PCI Express
  - PCMCIA cards
  - Industry Standard Architecture (ISA)



# PC Buses (continued)



**Figure 4-3** A PCI/PCI-X NIC



**Figure 4-4** A PCIe x1 NIC

# PC Buses (continued)



Figure 4-5 A Cardbus NIC

# PC Buses (continued)

Table 4-1 Common bus types

Bus Type	Maximum Transfer Rate	Bus Size	Use
ISA	16 MBps	8 or 16 bits	Only in PCs built before 2002
Extended ISA (EISA)	33 MBps	16 or 32 bits	Obsolete
Micro Channel Architecture (MCA)	264 MBps	16 or 32 bits	Obsolete
PCI	533 MBps	32 and 64 bits	Standard
PCI-X	4 GBps	32 and 64 bits	Servers, high-end workstations
PCI Express (PCIe)	8 GBps	1 to 16 serial lanes	Servers, high-end workstations
PCMCIA	132 MBps	32 bits	Laptops

# Other PC Interfaces Used for Networking

- Although the following interface technologies don't replace the buses in most typical PCs, they do offer other ways to attach computers to networks:
  - Universal Serial Bus (USB)
    - USB 1.0 can operate at up to 12 Mbps
    - USB 2.0 can operate at up to 480 Mbps
  - FireWire (also known as IEEE 1394)
    - Can operate up to 400 Mbps
    - IEEE 1394b supports transfer rates up to 3200 Mbps

# Principles of NIC Configuration

- Microsoft introduced **Plug and Play (PnP)** architecture with Windows 95
  - Defines a set of configuration protocols so that a computer can communicate with its peripherals during the **power-on self test (POST)** sequence and auto-negotiate a working configuration
- NIC configuration involves modifying settings
  - Interrupt request line (IRQ)
  - Base I/O port
  - Base memory address

# Integrated NICs

- **On-board NICs:** Most PC motherboard and laptop computer manufacturers integrate the network interface directly on to the motherboard
  - Might not meet a user's needs
    - Wrong media
    - Wrong speed
    - Wrong architecture
  - Most on-board NICs are suitable for most users' requirements

# Making the Network Attachment

- NICs perform several vital roles to coordinate communications between computer and network
  - Establishing a physical link to networking medium
  - Generating signals that traverse networking medium
  - Receiving incoming signals
  - Implementing controls for when to transmit signals to or receive signals from the network medium
- It is essential that you matching the adapter you choose with the medium it must attach to
- Some NICs support multiple media types, and configuration is usually automatic or uses SW

# Choosing Network Adapters for Best Performance

- The hardware-enhancement NIC options include:
  - Direct Memory Access (DMA)
  - Shared adapter memory
  - Shared system memory
  - Bus mastering
  - RAM buffering
  - On-board co-processors
  - Various security options
  - Traffic management (**Quality of Service (QoS)**)
  - Automatic link aggregation
  - Improved **fault tolerance**
  - Improved management features



# Choosing Network Adapters for Best Performance (continued)

- Increased performance features have payoffs for servers that might not apply to workstations
  - The following is a checklist for purchasing NICs:
    - *Bus width*—Higher is better
    - *Bus type*—Use 64-bit PCI-X or PCIe for servers
    - *Memory transfer*—Shared memory outpaces I/O or DMA
    - *Special features*—Choose security, management, protocol-handling, and hot-plug capabilities
    - *Bus mastering*—Important for servers
    - *Vendor factors*—Look for quality, reliability, staying power, and reputation

# Special-Purpose NICs

- In addition to straightforward network adapters, several types of cards deliver specialized capabilities
  - They include interfaces for wireless networks, as well as a feature for so-called diskless workstations (“thin clients”), which must access the network to load an OS when they boot
    - These cards are said to support remote booting or remote initial program load

# Wireless Adapters

- Wireless interfaces usually incorporate some or all of the following components:
  - Indoor antenna and antenna cable
  - Software to enable the adapter to work with a particular network environment
  - **Diagnostic software**
  - Installation software
- Wireless NICs are commonly used with an access point to add wireless elements to an existing LAN
- Select: speed, wireless standard, other (e.g., security)

# Wireless Adapters (continued)



Figure 4-6 A PCI bus wireless NIC

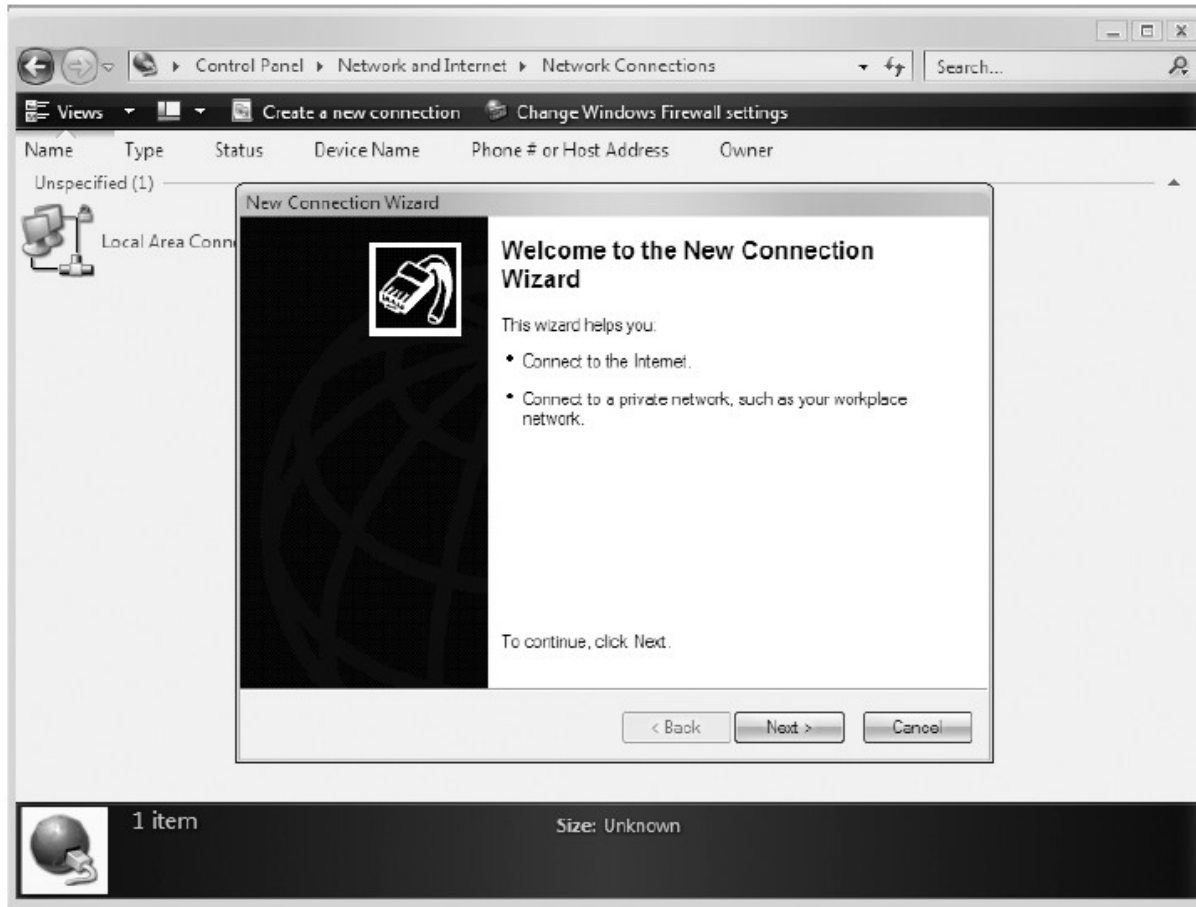
# Remote Boot Adapters

- The network must be the source of access to the programs needed to start a **diskless workstation**
  - Some NICs include a chip socket for a special bit of circuitry called a **Boot PROM**, which is referred to as preboot execution environment (PXE) compliant
  - Remote boot adapters offer several advantages
    - Cost savings because no hard drive is required
    - Improved reliability (hard drives are a common source of problems)
    - Security is increased (no sensitive data can be stored on the computer)
    - Virus attacks are useless

# Driver Software

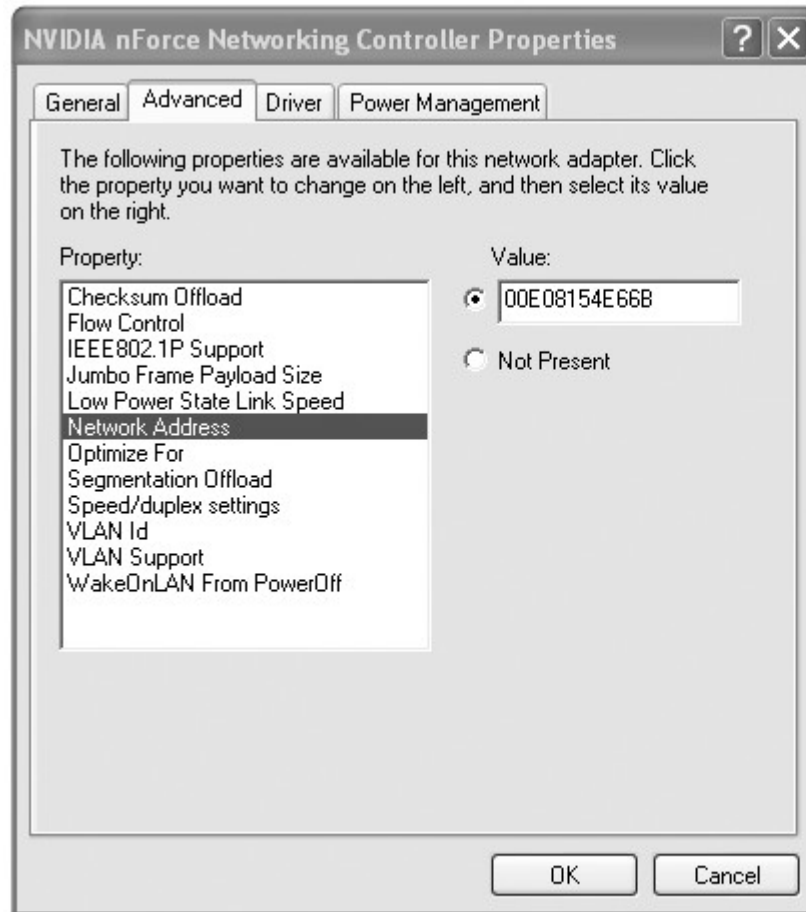
- **Device driver:** small, specialized program that represents a device to an OS and manages communications between the OS and NIC
- Incorrect/poorly written drivers can have negative impact on performance or prevent PC from booting
- Major vendor standards for drivers
  - Network Device Interface Specification (NDIS)
  - Win32 Driver Model (WDM)
  - Open Data-link Interface (ODI)
- Installing a driver for a NIC is usually easy

# Driver Software (continued)



**Figure 4-7** The New Connection Wizard in Windows Vista

# NIC Driver Configuration



**Figure 4-8** The Advanced tab of the NIC's Properties dialog box



# NIC Driver Configuration (continued)



**Figure 4-9** The Driver tab of the NIC's Properties dialog box

# Wireless NIC Configuration

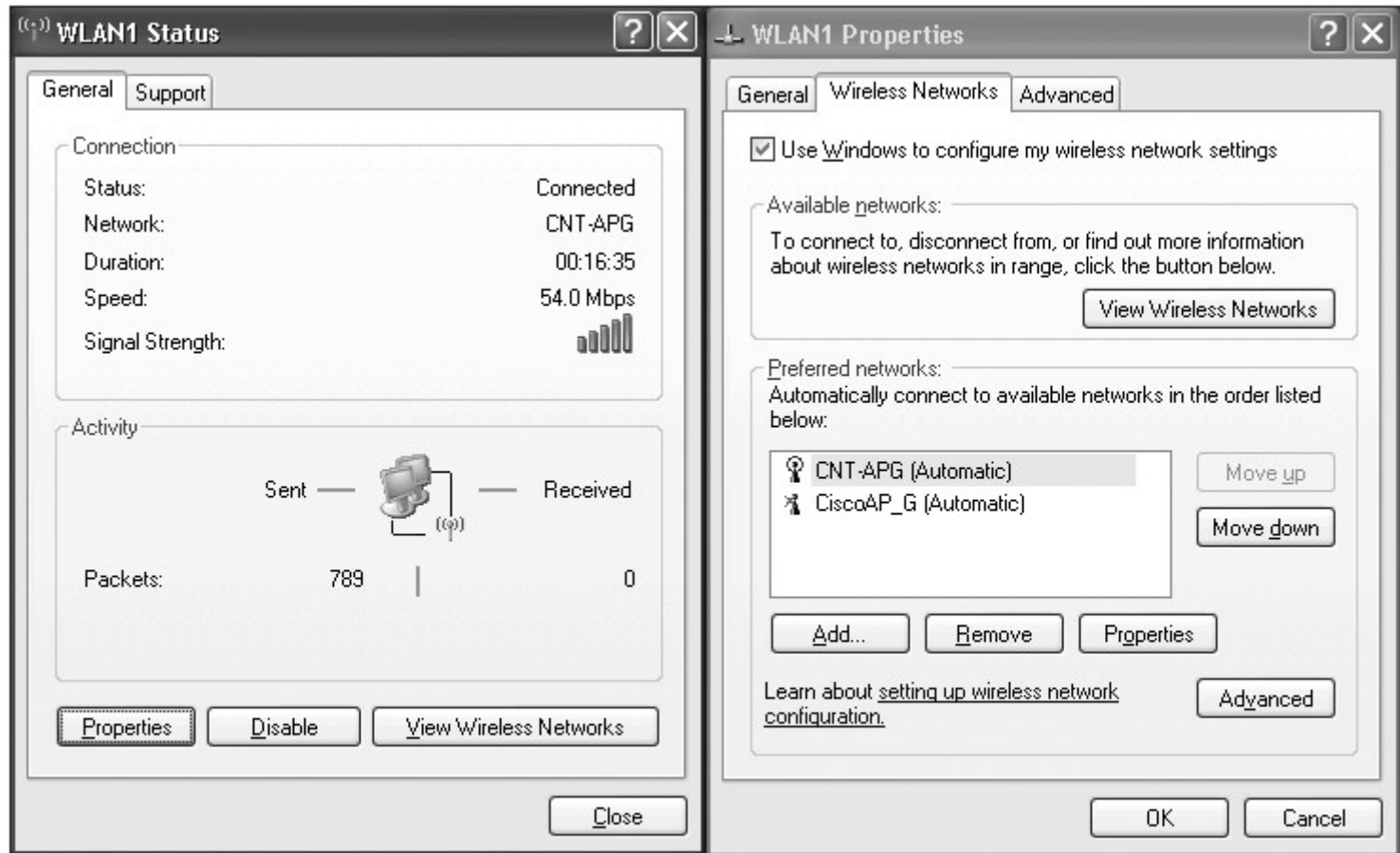
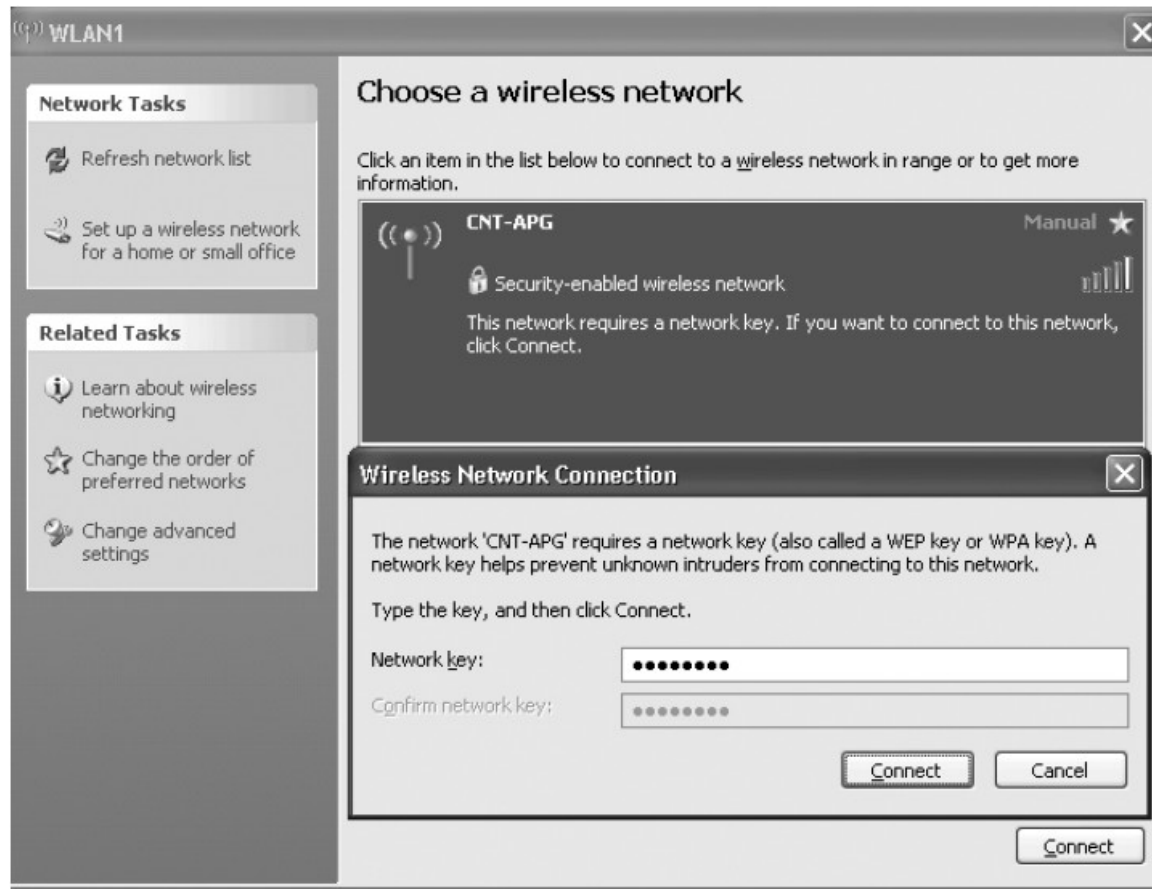


Figure 4-10 The Status and Properties dialog boxes for a wireless NIC

# Wireless NIC Configuration (continued)



**Figure 4-11** A wireless client connecting to a wireless network

# Summary

- NICs supply the interface between a computer and the networking medium
  - When sending data, a NIC reformats outgoing data from the parallel form that arrives through the computer's bus to the serial form used over most media; to receive data, the process is reversed
- NICs have options that must be set for an adapter to make a working network connection (usually PnP)
- NIC's edge connector must match the PC slot
- Many motherboards have integrated NICs
- Network adapters can have a profound effect on overall network performance

# Summary (continued)

- When purchasing a network adapter, consider the following checklist: bus width, bus type, memory transfer, special features (such as security), bus mastering, and vendor factors (such as support)
- When purchasing a wireless NIC, keep in mind the Wi-Fi standard you want to use
- Driver software permits a NIC to communicate with a computer's operating system
  - NIC driver configuration can be auto-configured, or it might require setting some options