CHAPTER 20

Network Communications

This chapter presents requirements and recommendations for network adapters and related technologies.

Network communications requirements are based on Network Driver Interface Specification (NDIS) 5.0, which defines the networking requirements, services, terminology, and architecture for Windows 98 and Windows 2000 Professional operating systems. For background information about NDIS 5.0, see the web site at http://www.microsoft.com/hwdev/network/.

Note: References to adapters, network interfaces, and so on in this chapter should be taken to apply to add-on network adapter cards, network implementations on the system board, and external network interfaces equally and without preference for any of these types of implementation, unless otherwise noted.

Notice also that, as for all PC 99 requirements, if it is planned that a specific recommended feature will become a requirement in future versions of these guidelines, it is specifically noted in the text.

Contents

System Requirements for Network Communications

This section summarizes the network communications features required for PC 99 systems.

20.1. PC system includes network adapter

Consumer	*Office*	*Mobile*	*Workstation*	*Entertainment*
Recommended	*Required*	*Recommended*	*Required*	*Recommended*

It is recognized that OEMs supply Office PC systems to corporations for networking purposes in situations where the customer will insert network adapters at the end-user site. If a network communications device is present in the system, it must meet the minimum requirements for network adapters defined in this chapter. Office PC 99 systems submitted for compliance testing must include either a network adapter or a modem.

20.2. PC system includes internal or external ISDN device

Consumer	*Office*	*Mobile*	*Workstation*	*Entertainment*
*Recommended**	*Recommended*	*Recommended*	*Recommended*	*Recommended**

If an ISDN device is present in the system, it must meet the minimum requirements defined in “ISDN Requirements” in this chapter. For information about serial ISDN devices, see Chapter 19, “Modems.”

Note: For items 20.2–20.6 marked with an asterisk (*) symbol, inclusion of either an asymmetric digital subscriber line (ADSL) modem, ISDN device, or home networking adapter for Internet access is recommended. For higher-speed multimedia networking, an ADSL modem, cable modem, or home networking adapter is recommended. Implementing these recommendations will provide a high-quality Internet connection, improving the user experience.

20.3. PC system includes cable modem

Consumer	*Office*	*Mobile*	*Workstation*	*Entertainment*
*Recommended**	*Recommended*	*Recommended*	*Recommended*	*Recommended**

A cable modem is not a required feature for any PC 99 system. However, if implemented, the device and driver must meet the guidelines defined in “Cable Modem Requirements” in this chapter.

20.4. PC system includes ATM adapter

Consumer	*Office*	*Mobile*	*Workstation*	*Entertainment*
Optional	*Optional*	*Optional*	*Optional*	*Optional*

An asynchronous transfer mode (ATM) adapter is not a required feature for any PC 99 system. However, if implemented, the device and driver must meet the guidelines defined in “ATM Adapter Requirements” in this chapter.

20.5. PC system includes ADSL adapter

Consumer	*Office*	*Mobile*	*Workstation*	*Entertainment*
*Recommended**	*Recommended*	*Recommended*	*Recommended*	*Recommended**

An ADSL device is a not required feature for any PC 99 system. However, if implemented, the device and driver must meet the guidelines defined in "ADSL Requirements" later in this chapter.

20.6. PC system includes satellite or broadcast receiver with NDIS driver

Consumer	*Office*	*Mobile*	*Workstation*	*Entertainment*
*Recommended**	*Recommended*	*Recommended*	*Recommended*	*Recommended**

For information about the requirements for supporting a broadcast receiver, which requires NDIS 5.0 support, see Chapter 15, "Video and Broadcast Components."

Network Adapter Requirements

This section defines basic hardware feature requirements for network adapters. Many of these requirements also apply to other network communications devices such as ISDN, cable modem, and ADSL. The applicable requirements for each device category are listed in the related sections later in this chapter.

20.7. Adapter uses NDIS 5.0 miniport driver

Required

The network adapter driver must be based on and comply with NDIS 5.0 in order to take advantage of new operating system capabilities. The driver must follow the NDIS miniport driver model defined in the Windows 2000 DDK.

PC 99A clarification: Network adapter drivers must follow the NDIS miniport driver model defined in "Network Drivers – Design Guide and Reference" in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/101rm_9t9j.htm). Guidelines for connection-oriented media are presented in Part 2, Chapters 1-7, 9 and Part 4, Chapter 1 of the "Network Drivers Design Guide" in the Windows 2000 DDK.

Documentation for both integrated and separated call managers is included in "Part 4: Connection-Oriented NDIS" in the "Network Drivers Design Guide" in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/401condis_8cfb.htm).

Important: The development of full MAC drivers is no longer supported. Support for full MAC drivers in the operating system will be removed in future versions of Windows operating systems.

If the network device is for connection-oriented media, such as ATM, ISDN, frame relay, or X.25, it must have a connection-oriented miniport driver that follows the connection-oriented model defined for NDIS 5.0 in the Windows 2000

DDK. Also, for connection-oriented media, there needs to be an NDIS 5.0 call manager driver as defined in the DDK.

In some cases, such as ATM, the call manager driver is included in the operating system. Consequently, for an ATM adapter, the vendor needs to provide only an NDIS 5.0 connection-oriented miniport driver. For connection-oriented media such as ISDN or X.25, the vendor must provide a call manager driver with the hardware, because the call manager is not included in the operating system. Call manager support can be integrated in the connection-oriented miniport driver or implemented as a separate NDIS 5.0 call manager driver. Documentation for both integrated and separated call managers is included in the Windows 2000 DDK.

An intermediate NDIS 5.0 miniport driver is required for network adapters that connect to the PC using IEEE 1394 or USB buses. This driver exposes its media type to NDIS at its upper edge, and it interfaces with the appropriate bus driver (IEEE 1394 or USB) at its lower edge.

20.8. Intermediate NDIS 5.0 miniport driver is deserialized

Recommended

NDIS 5.0 introduces support for deserialized miniports. This enables performance improvements and scalability on Windows NT and Windows 2000 multiprocessor systems.

For serialized miniports, NDIS simplifies the driver development by implementing the lock and queue management on behalf of the miniport driver. When these drivers are called, NDIS is always called before the miniport driver is entered, which enables NDIS to maintain the lock states and manage the queues of serialized miniport drivers.

This is not always the case with intermediate miniport drivers, where the driver can be called directly by another driver outside NDIS, such as the USB bus driver. Therefore, intermediate miniport drivers should be written as deserialized drivers implementing the lock and queue management in the driver.

20.9. Full-duplex adapter automatically detects and switches to full duplex mode

Required

If both the network adapter and switch port in a link pair support full duplex and there exists a standard way for each to detect and negotiate the duplex mode, then the network adapter must negotiate full duplex mode operation by default. Half duplex mode can be used if that is the only mode supported by one or both link partners, or it can be manually configured if warranted by special conditions. The goal is to configure this setting automatically without end-user intervention.

20.10. Adapter automatically senses presence of functional network connection

Required

Where the network allows it, the network adapter must be capable of dynamically determining whether it is functionally connected to a link partner such as a hub, switch, or router. The device must indicate the link state in the following cases:

- At boot time
- After returning to D0 power state
- When the link state changes while in the D0 power state (no time limit is specified for the required detection or status indication)

If the adapter is on an expansion card not used as a boot device, then the device drivers can determine the presence of the functional link. If the adapter is not functionally connected to a link partner, the miniport driver must provide appropriate NDIS status indication using support for cable sense in NDIS 5.0.

For information about NDIS status codes and indication mechanisms, see the Windows 2000 DDK.

PC 99A clarification: For information about NDIS status codes and indication mechanisms, see the NdisMIndicateStatus topic in the "Network Reference" in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/103ndisx_5nn6.htm).

20.11. Adapter automatically senses transceiver type

Required

Network adapters that support multiple transceivers must be capable of automatically detecting which transceiver type is connected to the network unless detection is not possible with the network media available. The network adapter then must automatically drive the correct connection. In all cases, the user must not be required to set jumpers or manually enter information to inform the operating system of the transceiver type.

20.12. Adapter can transmit packets from buffers aligned on any boundary

Required

Buffer alignment refers to whether a buffer begins on an odd-byte, word, double word, or other boundary. Adapters must be able to transmit packets, any of whose fragments are on an odd-byte boundary.

For performance reasons, it is recommended that packets be received into contiguous buffers on a double word boundary.

20.13. Adapter communicates with driver across any bridge

Required

If the adapter uses a bridge, all communications must be free of errors across any bridge, such as a PCI bridge adapter.

20.14. Adapter supports filtering for at least 32 multicast addresses

Required

This requirement applies to networking technologies such as Ethernet that support multicast. This requirement does not apply to technologies such as Token Ring, which distributes Internet Protocol (IP) multicast traffic using the functional address as specified in RFC 1469.

This capability is needed to support push technology applications such as Microsoft NetShow™ server, Active Desktop™ interface, and Internet Explorer 4.0 or later version. The minimum required capability is for filtering 32 multicast addresses, also known as channels.

20.15. Adapter and driver support promiscuous mode

Required

Promiscuous mode ensures that the adapter can be used with Microsoft Network Monitor Agent. This requirement applies only to LAN (non-switched) media.

Notice that, by default, promiscuous mode is not turned on. Enabling promiscuous mode should be possible only by using the Microsoft Network Monitor Agent or another similar administrative application.

20.16. Adapter is compatible with remote new system setup capabilities if used as a boot device

Required

On a system that uses a network adapter to support installation of the operating system, the network adapter must be compatible with remote new system setup capabilities as defined in the *Network PC System Design Guidelines, Version 1.0b*.

An Office PC system must have a network adapter that meets this requirement and the necessary system BIOS capabilities to use the adapter as a boot device, as defined in requirement 3.5, “BIOS meets PC 99 requirements for OnNow support.”

20.17. PCI network adapters are bus masters

Required

To improve the system performance by offloading the processor load, PCI network adapters must be bus masters.

20.18. Device Bay-type network adapter meets PC 99 requirements

Required

Any network communications device designed as a Device Bay peripheral must interface with either USB, IEEE 1394, or both, and must support relevant USB device class specifications. All Device Bay peripherals must meet the requirements defined in *Device Bay Interface Specification, Version 1.0*.

20.19. USB or IEEE 1394 device meets specifications for network communications devices

Recommended

USB network communications device vendors should participate in the USB Device Working Group's effort to define networking extensions to the USB Class Definitions for Communications Devices. Vendors also should implement their hardware to this specification when it is released.

Vendors are also encouraged to participate in the definition and implementation of similar IEEE 1394 efforts.

20.20. Network adapter and driver supports priority for IEEE 802-style networks

Recommended

Windows Quality of Service (QoS) components provide link layer priority information to NDIS 5.0 miniport drivers in each transmitted packet's NDIS_PER_PACKET_INFO structure. Priority values are derived by mapping IETF Integrated Services (intserv) service typed to IEEE 802.1p priority values, referred to as the "user priority" object in the draft available on the web at http://search.ietf.org/internet-drafts/draft-ietf-issll-is802-svc-mapping-01.txt, which is likely to be superceded by later draft or final specification. The intserv service type used for the mapping is determined by QoS-aware applications, or on behalf of the application, by QoS-aware operating system components.

IEEE 802.1p/q-capable Ethernet drivers are expected to use the priority level indicated in the NDIS_PER_PACKET_INFO structure to generate the responding field in the IEEE 802.1p/q MAC headers of transmitted packets. Similarly, these drivers are expected to extract the appropriate information from the MAC headers of received packets and to copy the priority to the NDIS_PER_PACKET_INFO structure before indicating the packet to higher protocol layers.

Notice that any link layer driver has the ability to interpret the priority information in the NDIS_PER_PACKET_INFO structure and use it as appropriate for the particular media.

For more information, see the Windows 2000 DDK and "QoS: Assigning Priority in IEEE 802-style Networks," available on the web at http://www.microsoft.com/hwdev/devdes/qos.htm.

PC 99A clarification: For more information, see “Quality of Service” in the “Network Drivers Design Guide” in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/401condis_5dyf.htm). See also the white paper “QoS: Assigning Priority in IEEE 802-style Networks,” available on the web at http://www.microsoft.com/hwdev/devdes/qos.htm.

ISDN Requirements

This section summarizes the design features for ISDN devices.

In this section, “internal ISDN device” refers to the ISDN terminal adapter, which exposes raw access to its B channels using NDIS miniports. NDIS miniports could also be attached to the PC using WDM-supported bus classes such as USB or IEEE 1394, which would physically be an external device.

“ISDN modem” refers to an ISDN device that exposes itself as a modem controlled by the AT command set. To the operating systems, these devices look like modems and can be used as modems, the hardware manufacturer provides the following:

- A modem INF file for installing the device and for telling the Unimodem which commands to use to control the ISDN device.
- The ability to interpret the standard modem AT command in the ISDN device itself or in a serial port driver. For more information, see the TIA-602 specification, a subset of ITU V.250.

This section defines general requirements for ISDN and specific requirements for ISDN terminal adapters. For information about the requirements for ISDN modems, see Chapter 19, “Modems.”

ISDN is recommended, but not required, for high-speed connections. If ISDN is implemented in a PC 99 system, it must meet the requirements defined in this chapter. For Plug and Play, power management, and driver support requirements, see “PC 99 Design for Network Communications” later in this chapter.

20.21. Internal ISDN device meets PC 99 network adapter requirements

Required

The ISDN device driver and its INF file must be based on NDIS 5.0. to ensure user-friendly installation and operation of the ISDN adapter.

The following requirements must be met, as defined in “System Requirements for Network Communications” earlier in this chapter:

- 20.7, “Adapter uses NDIS 5.0 miniport driver, with call manager support” for connection-oriented media
- 20.10, “Adapter automatically senses presence of functional network connection”

- 20.12, “Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send”
- 20.13, “Adapter communicates with driver across any bridge”
- 20.18, “Device Bay-type network adapter meets PC 99 requirements”
- 20.19, “USB or IEEE 1394 device meets specifications for network communications devices”

20.22. Internal ISDN device supports synchronous HDLC framing

Required

High-level data link control (HDLC) framing is a standard for sending synchronous data. Other framing methods are allowed if the miniport driver provides simple HDLC framed synchronous Point-to-Point Protocol (PPP) packets to NDIS.

20.23. NDIS interface and driver support raw unframed synchronous B channel I/O

Required

The internal ISDN device and the driver must support raw, unframed (non-HDLC) synchronous B channel I/O at 64 Kbps per B channel, with each B channel individually accessible. This will enable H.320 as well as voice calls over ISDN without audio breakup.

For these raw interfaces, the direct path to each B channel must support synchronous transmission and reception of H.221 frames, which are of 20 ms duration. To achieve this without additional latency to H.221, there must be support for overlapped I/O buffers at intervals of less than or equal to 20 ms in each direction. As underruns or overruns cause degraded audio, hardware buffering must be adequate to prevent B channel underruns and overruns. For Windows 98 and Windows 2000, 20 ms is adequate.

This can be achieved by making buffering software configurable with adequate range to handle foreseeable real-world conditions. The miniport driver should make I/O completion callbacks to NDIS for each I/O buffer as soon as the I/O for that buffer is complete; it should not coalesce or delay callbacks.

20.24. ISDN driver supports unattended installation, with limitations

Required

Configuration of the dependent parameters, such as service profile IDs (SPIDs) and switch-type IDs, must be done through the ISDN Configuration wizard included in the operating system.

20.25. ISDN device with U-interface includes built-in NT-1 capability

Recommended

Note: This recommendation applies only in the United States.

NT-1 (network terminator) splits the duplexed transmit and receive signals from the ISDN line into separate transmit and receive components. An ISDN device with a built-in NT-1 can connect directly to the ISDN line. However, doing so prevents other devices from being attached to the ISDN line, because only one NT-1 can be connected to an ISDN line.

Therefore, if the ISDN device has built-in NT-1, it is also recommended that it has a connector for either an analog phone or another ISDN device (S/T-interface), such as ISDN phone. Adding an analog (POTS) port or S/T-interface to the ISDN device delivers convenience to the SOHO market, allowing customers to use one ISDN line to meet all telecommuting needs at minimal cost.

20.26. ISDN device includes software-selectable terminating resistors

Required

If the ISDN device has an S/T-interface for connecting additional ISDN devices, it must also have software-configurable terminating resistors that can be selected on or off. The default value of the termination is on in North America, but off in all other countries, where phone companies unconditionally provide the termination.

Cable Modem Requirements

A cable modem connected to a PC is one system component that cable-television operators use to deliver high-speed cable data services to customers.

Cable modem provides two-way services: Data flows downstream from the cable operator’s head end and upstream from the customer’s PC. At the head end, the cable data system is terminated by the cable modem termination system (CMTS), which terminates the upstream and downstream radio frequency (RF), MAC layer, and possibly Layer 3 protocols from the cable side. CMTS provides the internetwork connection between the cable system and the rest of the network at the head end. CMTS can be implemented on a proprietary hardware platform or a PC platform running Windows NT or Windows 2000 to provide different networking functions such as routing or QoS support, for example, RSVP.

Some implementations transmit upstream using narrow-band networks, such as ISDN or analog modem. But as cable companies upgrade their networks, an increasing number of RF return modems, for example, two-way modems, are being deployed. Two-way modems are preferred because they are always connected, perform better, and do not tie up phone lines or require modem banks.

The three current cable modem specifications are:

- Data-Over-Cable Service Interface Specification (DOCSIS), developed by the Multimedia Cable Network System (MCNS) consortium.
- IEEE 802.14, developed by IEEE.

- Digital Video Broadcasting/Digital Audio-Visual Council (DVB/DAVIC), developed by DAVIC and DVB and adopted by European Telecommunication Standards Institute (ETSI) and International Telecommunication Union (ITU).

Industry support for DOCSIS is growing rapidly in North America. In present form, its upper layers fully describe IP traffic encapsulated by 802.3/DIX Ethernet framing. ATM is left for future study.

External Ethernet DOCSIS cable modems provide IEEE 802.1d bridging for one or more Customer Premises Equipment. A PC attaches to the cable modems indirectly through its 10BASE-T network adapter. Integrated cable modems attach directly to the PC over buses such as USB, PCI, and IEEE 1394 and they require a vendor-supplied NDIS 5.0 miniport driver. This driver exposes an 802.3/DIX Ethernet adapter interface to the operating system and it interfaces to the cable modem hardware using the appropriate bus (PCI) or bus interface driver, USB or IEEE 1394 at its bottom edge.

In contrast to DOCSIS, both the IEEE 802.14 and the DVB/DAVIC efforts are focused on using ATM, typically implementing an ATM adapter interface and using an NDIS 5.0 ATM miniport driver.

20.27. Device is implemented as an integrated cable modem

Recommended

An integrated cable modem is recommended. This means integrating everything onto a single device, from the cable modem's physical interface layer (RF coax connector) up through a standard PC 802.3/DIX Ethernet or ATM adapter MAC interface. In other words, the PC software perceives the integrated cable modem as a standard Ethernet or ATM network adapter.

An example of this is a USB-attached DOCSIS implementation that integrates cable modem Physical Media Dependent (PMD), downstream convergence, cable MAC, link security, 802.3/DIX MAC "adapter" filtering, and USB device interface functions in the same box. Similar devices can be implemented that are attached using PCI or IEEE 1394 buses.

20.28. Integrated cable modem meets PC 99 network adapter requirements

Required

For the integrated cable modem, the following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter:

- 20.10, "Adapter automatically senses presence of functional network connection"
- 20.12, "Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send"
- 20.13, "Adapter communicates with driver across any bridge"
- 20.17, "PCI network adapters are bus masters"

- 20.18, “Device Bay-type network adapter meets PC 99 requirements”
- 20.19, “USB or IEEE 1394 device meets specifications for network communications devices”

For an integrated cable modem exposing an ATM interface, the following requirements must be met as defined in “Network Adapter Requirements” earlier in this chapter:

- 20.7, “Adapter uses NDIS 5.0 miniport driver” for connection-oriented media

For an integrated cable modem exposing an Ethernet interface, the following requirements must be met as defined in “Network Adapter Requirements” earlier in this chapter:

- 20.7, “Adapter uses NDIS 5.0 miniport driver”
- 20.14, “Adapter supports filtering for at least 32 multicast addresses”
- 20.15, “Adapter and driver support promiscuous mode”

20.29. Integrated cable modem exposes an ATM or Ethernet interface

Required

An integrated cable modem should expose an ATM or Ethernet interface to the operating system. For the specific requirements if an ATM/cable modem solution is implemented, see “ATA Adapter Requirements” later in this chapter.

ATM Adapter Requirements

This section summarizes requirements for ATM hardware.

The NDIS 5.0 extensions provide kernel-mode NDIS 5.0 client drivers with direct access to connection-oriented media such as ATM. The new architecture for Windows 98 and Windows 2000 extends native ATM support to Windows Sockets 2.0 (WinSock), Telephony API (TAPI), and DirectShow-based applications by providing system-level components that map the applicable WinSock, TAPI, and DirectShow APIs to NDIS 5.0, extending direct ATM access to user-mode applications.

If ATM is included in a PC 99 system or is specifically designed for Windows 98 or Windows 2000, it must meet the requirements defined in this chapter. For basic requirements for Plug and Play, power management, and driver support, see “PC 99 Design for Network Communications” later in this chapter.

For more information related to these requirements, please refer to “ATM Layer Specification,” in *ATM User-Network Interface Specification, Version 3.1*. This specification includes references to other relevant specifications.

20.30. ATM adapter meets PC 99 network adapter requirements

Required

The following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter:

- 20.7, "Adapter uses NDIS 5.0 miniport driver" for connection-oriented media
- 20.10, "Adapter automatically senses presence of functional network connection"
- 20.12, "Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send"
- 20.13, "Adapter communicates with driver across any bridge"
- 20.17, "PCI network adapters are bus masters"
- 20.18, "Device Bay-type network adapter meets PC 99 requirements" and
- 20.19, "USB or IEEE 1394 device meets specifications for network communications devices"

20.31. ATM adapter supports a minimum number of simultaneous connections

Required

The Virtual Path Identifier (VPI) and Virtual Channel Identifier (VCI) ranges supported by the adapter affect the maximum number of simultaneous connections supported on a system.

This affects the applicability of the adapter to ATM applications such as LAN emulation, where at least one dedicated VC is created between each pair of communicating ATM hosts.

System type	Simultaneous connections
Client (ATM adapter)	64 or more
Client (Integrated ATM/ADSL adapter)	32 or more

PC 99A correction: For the Client (Integrated ATM/ADSL adapter), the minimum required support is for 16 simultaneous connections.

A sample driver is provided in the Windows 2000 DDK to guide developers in properly supporting resources to meet this requirement.

PC 99A clarification: A sample driver is provided at %ntddk%\src\network\ndis\atmsmple in the Windows 2000 DDK to guide developers in properly supporting resources to meet this requirement.

20.32. ATM adapter supports all service types defined by the ATM Forum

Recommended

The ATM adapter should support the constant bit rate (CBR), variable bit rate (VBR), available bit rate (ABR), and unspecified bit rate (UBR) service types as defined by the ATM Forum.

20.33. ATM adapter supports UBR service type

Required

UBR is used by default for standard ATM services such as LAN Emulation and IP over ATM. In addition, PPP is a widely used model for residential network access, and UBR is used by default for PPP-over-ATM virtual circuits. Therefore, it is required for ATM adapters to support the UBR service type.

20.34. ATM adapter supports a minimum number of simultaneously active VBR or CBR connections

Required

Support is required for at least two simultaneously active VBR or CBR connections for basic ATM signaling and management.

Support for at least six VBR/CBR connections is needed for ATM adapters that support multimedia or other traffic that demands QoS.

20.35. ATM adapter supports traffic shaping

Required

The ATM adapter must support and enforce all the traffic-shaping rules specified for each service type it supports, including CBR, VBR, ABR, and UBR.

This includes enforcement of peak cell rate on UBR virtual circuits as described in the following requirement.

20.36. ATM adapter enforces PCR on UBR virtual circuits

Required

ATM adapters can be used to connect the router, remote access, and content servers to the public ATM network. High-speed residential broadband access networks such as ADSL and cable modem can enable direct connection, using an ATM virtual circuit, from home or small office computers to these servers.

When the Windows Dial-Up Networking user interface is used to connect from the home or SOHO computer to the remote router or server, a PPP link is established over an ATM virtual circuit, using the UBR service type. When creating the UBR virtual circuit, Windows will request upstream and downstream line rates, or Peak Cell Rates (PCR), equal to the upstream and downstream line rates provided for the user. Windows uses the ATM Interim Local Management Interface (ILMI) protocol to obtain information such as the user’s line rates provided by the public network.

To avoid packet loss and ensure efficient network utilization, it is critical that all ATM adapters, integrated ATM/ADSL adapters, and ATM/cable modem adapters enforce requested PCR on UBR virtual circuits.

Because any ATM adapter might be installed in a server to which clients connect through the public network, this requirement applies to all ATM adapters.

20.37. ATM adapter and driver support dynamic link speed configuration

Required

When connected to a residential broadband network, ATM adapters must restrict the aggregate transmission rate across all active virtual circuits so that it does not exceed the upstream bandwidth provided by the residential broadband network.

Therefore, all integrated ATM/ADSL adapters and ATM/cable modem adapters must support aggregate shaping of upstream bandwidth, according to the provisioned upstream bandwidth, or the trained bandwith, whichever is lower. Some implementations can support rate adoption and lower-than-provisioned rates might be negotiated because of poor line conditions. In addition, because any 25 Mbps ATM adapter might be used to connect to an ADSL network by way of an external ADSL modem, it is required that all 25 Mbps ATM adapters support this as well. This support is optional for ATM adapters with line rates higher than 25 Mbps.

The Windows ATM Call Manager uses ILMI to query the public network to determine the maximum line rates provisioned for incoming and outgoing traffic. The Call Manager then uses the OID_GEN_CO_LINK_SPEED NDIS request (in SET mode) to set the line rate for both incoming and outgoing traffic, within which the adapter can shape the aggregate of all ATM traffic.

20.38. ATM adapter supports OAM

Recommended

Operation and maintenance (OAM) is needed for diagnostics.

This capability is recommended for Client systems. If implemented, it is required that received F4 and F5 loopback OAM cells must be responded to. Support for other layers, F1–F3, is optional.

20.39. ATM adapter supports buffer chaining (Tx + Rx)

Recommended

This feature is needed for large packets.

This capability is recommended for Client systems, but is required for Server systems.

ADSL Requirements

This section summarizes requirements for ADSL hardware.

Support is provided in the Windows 98 and Windows 2000 operating systems for ADSL adapters and external ADSL modems, such as those using USB, which provide a faster method for moving data over regular phone lines.

Recommended: Manufacturers should participate in developing standards for this technology and review the white paper jointly developed by over 30 leading ADSL vendors, *An Interoperable End-to-End Broadband Service Architecture over ADSL System, Version 3.0,* which discusses end-to-end service interoperability over ATM over ADSL. This paper is available at http://www.microsoft.com/hwdev/devdes/publicnet.htm. The core idea of this white paper (PPP over ATM over ADSL) has been adopted by the ADSL Forum.

20.40. ADSL device is implemented as an integrated ADSL modem

Recommended

An ADSL modem should be implemented. This means the integration of the ADSL modem, higher layer transmission and media access functions on a single network device. A typical implementation is an integration of ADSL modem and an ATM interface on a single PCI network adapter. Another example is a similar device that connects to the PC using the USB or IEEE 1394 buses.

An external ADSL modem, other than IEEE 1394 or USB, should have an ATM interface for the ADSL modem to PC connection. In addition, an Ethernet interface can be included.

20.41. Integrated ADSL modem meets PC 99 network adapter requirements

Required

For the integrated ADSL modem, the following requirements must be met as defined in “Network Adapter Requirements” earlier in this chapter:

- 20.10, “Adapter automatically senses presence of functional network connection”
- 20.12, “Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send”
- 20.13, “Adapter communicates with driver across any bridge”
- 20.17, “PCI network adapters are bus masters”
- 20.18, “Device Bay-type network adapter meets PC 99 requirements”
- 20.19, “USB or IEEE 1394 device meets specifications for network communications devices”

For the integrated ADSL modem exposing ATM interface, the following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter.

- 20.7, "Adapter uses NDIS 5.0 miniport driver" for connection-oriented media

For the integrated ADSL modem exposing Ethernet interface, the following requirements must be met as defined in "Network Adapter Requirements" earlier in this Chapter.

- 20.7, "Adapter uses NDIS 5.0 miniport driver"
- 20.14, "Adapter supports filtering for at least 32 multicast addresses"
- 20.15, "Adapter and driver support promiscuous mode"

20.42. ATM/ADSL solution is implemented for integrated ADSL modems

Recommended

An integrated ADSL modem should expose ATM to the operating system. For ATM-specific requirements when an ATM/ADSL solution is implemented, see the requirements in "ATM Adapter Requirements" earlier in this chapter. This should comply with the PPP-over-ATM architecture discussed earlier.

Note: ATM/ADSL is required for UADSL implementations In the current market, both ATM/ADSL-based and Ethernet/ADSL-based implementations provide full-rate ADSL services. The PPP/ATM/ADSL implementation referred to in this section is required to support Universal ADSL-based services that will be available to residential markets within the next few years.

20.43. ADSL modem supports DMT line encoding

Recommended

The ADSL modem should support Discrete Multi-tone (DMT) line encoding, which is recognized as the industry standard for ADSL by ANSI as the T1.413 Issue 2 specification, and also by the Universal ADSL Working Group (UAWG). For information, see http://www.uawg.org.

Note: DMT is required for UADSL implementations. The UAWG has adopted DMT specified by T1.413, with modifications being made for it to work in a splitterless environment.

20.44. ADSL modem supports rate adaptation

Recommended

On a rate-adaptive ASDL (RA-ADSL), the downstream and upstream data rates should be independently set either by an automatic adaptive algorithm or by manual selection.

RA-ADSL provides the capability to optimize the transmission speed and performance over a range of telephone-line loop distances. Adaptive channel

equalization ensures more robust performance in the presence of channel impairments and narrow-band interference.

This also helps telephone companies to provide RA-ADSL access on their existing networks. RA-ADSL products can be provided on many telephone lines without costly and time-consuming network upgrades.

IrDA Requirements for Network Communications

The interface between Infrared Data Association (IrDA) hardware (framers) and the Windows IrDA stack is through NDIS 5.0 miniport drivers that adhere to the conventions defined in *Infrared Extensions to the NDIS Version 4.0 Functional Specification*. The Windows IrDA stack expects that hardware and NDIS drivers deal with framing, transparency, and error detection, as well as supporting media-sense and speed-change commands. Miniport drivers are responsible for discarding incoming frames with bad cyclic redundancy checks. These frames must never be forwarded to the protocol.

Although the IrDA protocol stack in Windows 2000 is different from the one on Windows 98, the Windows 2000 DDK should be used for driver development for both platforms. The Windows 2000 IrDA protocol stack imposes stricter requirements on drivers than the protocol stack on Windows 98.

20.45. Infrared device meets PC 99 network adapter requirements

Required

The following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter:

- 20.7, "Adapter uses NDIS 5.0 miniport driver"
- 20.12, "Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send"
- 20.13, "Adapter communicates with driver across any bridge"
- 20.17, "PCI network adapters are bus masters"
- 20.18, "Device Bay-type network adapter meets PC 99 requirements"
- 20.19, "USB or IEEE 1394 device meets specifications for network communications devices"

20.46. Infrared device supports both FIR and SIR

Required

All infrared devices must comply with approved IrDA specifications, including support for SIR and FIR data devices.

20.47. IrDA hardware supports unattended driver installation

Required

FIR Plug and Play hardware must report a unique Plug and Play ID that matches the combination of the chip set, transceiver, and any other system-specific parameters, in order for the operating system to find and install the correct INF and the associated driver for the IrDA hardware.

In the best case, the IrDA hardware has only one Plug and Play ID associated INF file, and a miniport driver that can autodetect the transceiver type and other system-specific parameters. This enables the installation and configuration of the hardware and the driver without user intervention.

In other cases, for example, where the miniport driver cannot autodetect the transceiver type or any other system-specific parameters, a unique Plug and Play ID for each combination of the chip set and the transceiver type must be reported. Also, the vendor must provide for each combination an associated driver and INF file describing the configuration parameters.

Home Networking Requirements

Home networking is a significant new area with different constraints than conventional networking and few products currently on the market. Currently, important applications are sharing Internet access and peripherals, but new applications might develop.

Because this networking area is so new, it is appropriate that this guide set a standard for the quality of the user experience with as few hard technical standards as possible, allowing time for a marketplace to develop.

A Consumer PC system must include a modem or other Internet access device. However, in a home with networked PCs, some kind of gateway is desirable to enable simultaneous access to the Internet from multiple clients. Such a gateway can be implemented in PC software or embedded in a non-PC networking solution. These gateway functions can include networking services such as DHCP Proxy, NAT Router, and Firewall. All the PCs in this scenario must have a network adapter for peer-to-peer connectivity for accessing the Internet link provided by the home gateway.

Although there is no explicit speed requirement for home networking media, designers should recognize that higher bandwidth supports greater capabilities. For example, to support MPEG-2 playback, 1.5 Mbps is needed.

20.48. Home networking adapter meets PC 99 network adapter requirements

Required

The following requirements must be met as defined in “Network Adapter Requirements” earlier in this chapter:

- 20.7, “Adapter uses NDIS 5.0 miniport driver”
- 20.10, “Adapter automatically senses presence of functional network connection”
- 20.11, “Adapter automatically senses transceiver type”
- 20.12, “Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send”
- 20.13, “Adapter communicates with driver across any bridge”
- 20.18, “Device Bay-type network adapter meets PC 99 requirements”
- 20.19, “USB or IEEE 1394 device meets specifications for network communications devices”

Home networks will differ from traditional, homogeneous business networks because they are expected to incorporate many types of media and link layer protocols spanning a smaller number of hosts. Even though media types and link layer protocols will be optimized with respect to features such as bandwidth and isochrony, it is important that IP protocols be supported in every case in order to enable traditional PC-to-PC networking.

The following features are recommended:

- 20.14, “Adapter supports filtering for at least 32 multicast addresses”
- 20.15, “Adapter and driver support promiscuous mode,” for network media that confine network traffic signals within a single home
- 20.17, “PCI network adapters are bus masters”

20.49. Home networking uses appropriate media

Recommended

For new construction or remodeling, wiring or fiber cable capable of at least 100 Mbps over a distance of at least 100 meters should be implemented. An example would be using 100BaseT on CAT5 wiring.

Networking media solutions that do not require new wiring are also needed. Alternatives for these “no new wires” technologies include new uses for wireless technologies and for existing in-home power wiring, phone wiring, and cable TV (coaxial) wiring. There are organizations working on developing standards for home networking media, including the Home Phoneline Networking Alliance and the Home Radio Frequency Working Group.

All home networking implementations should comply with Federal Communication Commission (FCC) or regional regulatory requirements for use within residential environments.

20.50. Home networking media supports IP

Required

Any home networking media must support IP, yet not preclude the use of other protocols.

PC 99 Design for Network Communications

This section summarizes requirements related to the PC 99 design initiatives defined in Part 1 of this guide.

Plug and Play and Bus Design for Network Communications

The items in this section are requirements for Plug and Play capabilities.

20.51. Each device has a unique Plug and Play device ID

Required

For a system-board device, there must be a Plug and Play device-specific ID.

Each bus-specific device must provide Plug and Play device IDs in the manner required for the bus it uses, as defined in Part 3 of this guide. For example, a PCI device also must comply with PCI 2.1 requirements and provide a Subsystem ID and Subsystem Vendor ID as defined in Chapter 9, “PCI.”

20.52. Dynamic resource configuration is supported for all devices

Required

The system must be capable of automatically assigning, disabling, and relocating the resources used by a network device as necessary, using the method required for the related bus class. When an end user changes a device or adds it to the system, setting resource assignments must not require changing jumpers or switches on either the adapter or the system board. In the event of an irreconcilable conflict with other devices on the system, the system must be able to disable the device to prevent the system from stalling.

20.53. Plug and Play capabilities support multiple adapters

Required

For network communications devices, the Plug and Play IDs and resource support must be sufficient to automatically support the addition of multiple network communications devices to the system. This is true both for the same and different types of network communications devices.

20.54. All resource settings are reported in the user interface

Required

All resource settings must be viewable in Device Manager and in the adapter properties dialog boxes. All resource settings that can be changed by the user must

be changed using the standard Windows user interface, not by way of INI files or other setting files.

This implies that all device resources must be set and read through the standard interfaces provided by the bus on which the device resides. For PCI devices, this interface is the PCI configuration space. Also, device parameter settings must be stored in the registry.

Power Management for Network Communications

This section summarizes the specific power management requirements for network communications devices.

20.55. Device complies with device class power management reference specification

Required

The *Network Device Class Power Management Reference Specification, Version 1.0a*, provides definitions of the OnNow device power states (D0–D3) for network adapters. The specification also covers the device functionality expected in each power state and the possible wake-up event definitions for the class.

Network communications devices that directly attach to the PC over USB, PCI, and IEEE 1394 must comply with this specification.

20.56. Device supports wake-up events

Required

This requirement applies specifically to the following network communications devices and their associated NDIS 5.0 miniport drivers:

- Ethernet and Token Ring network adapters
- Integrated DOCSIS cable modems
- Other devices that transfer IEEE 802.3/DIX Ethernet framed packets

Network Device Class Power Management Reference Specification does not yet define wake-up mechanisms for ISDN adapters or any network communications adapter that uses ATM signaling.

The system must be capable of wake-up from a lower power state based on network events that are specified by the local networking software. This capability yields the result that any standard Windows network access—such as connections to shared drives and WinSock connections, plus service and management applications—can wake a system from lower power states transparently.

As defined in *Network Device Class Power Management Reference Specification*, a network adapter and its driver must support wake-up on receipt of a network wake-up frame. Support for wake-up on detection of a change in the network link

state or on receipt of a Magic Packet event is optional. Implementation details are described in the "Network Wake-up Frames" and "Network Wake-up Frame Details" sections of *Network Device Class Power Management Reference Specification, Version 1.0a* and in the Windows 2000 DDK. See also the implementation notes at http://www.microsoft.com/hwdev/devdes/netpm.htm.

PC 99A clarification: For information about supporting wake-up events in NDIS miniport drivers, see "Chapter 6: Power Management for Miniports" in "Part 2: Miniport NIC Drivers" in the "Network Drivers Design Guide" in Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/206pm_9h0n.htm).

The packet patterns that define the wake-up frames are provided to the NDIS 5.0 miniport driver by the operating system. To enable Wake-On-LAN capability for basic networking scenarios, the network adapter must be capable of storing information describing a minimum of three wake-up packet patterns, and it must be able to recognize wake-up packets based on pattern matches anywhere in the first 128 bytes of the packet.

Network adapters should be capable of storing information describing at least five wake-up packet patterns to enable more advanced applications, such as Wake-On-LAN capability on multi-homed systems or on receipt of multicast packets, in addition to the above basic scenarios.

PCI-based network adapters must support the generation of a power management event (PME# assertion) from the D3 cold device state if the physical layer technology is generally capable of operating under the voltage and current constraints of the D3 cold device state. For example, 100baseTX adapters can meet this requirement based on the state of the art available in mid-1998. 1000baseSX or 1000baseLX (gigabit Ethernet using optical fiber media) cannot meet this requirement because of the power required to operate the optical physical layer.

Device Drivers and Installation for Network Communications

This section summarizes requirements for network communications device drivers, in addition to the requirements for using an NDIS 5.0 miniport driver as defined in "System Requirements for Network Communications" earlier in this chapter.

20.57. Device drivers and installation meet PC 99 requirements

Required

The manufacturer does not need to supply a driver if a PC 99-compliant driver provided with the operating system can be used. If the manufacturer supplies a driver, it must comply with requirement 3.16, "Device driver and installation meet PC 99 requirements." The basic requirements include driver support for unattended installation and Help file support if special driver parameters are used.

For exceptions to unattended installation requirements for ISDN adapters, see "ISDN Requirements" earlier in this chapter.

20.58. Driver works correctly with Microsoft network clients and protocols

Required

This includes the 32-bit Microsoft client and NetWare-compatible clients provided with Windows, whether connected to a Windows 2000 or Windows NT-based server, a Novell NetWare 3.*x* or 4.*x* server, or a Windows-based peer server. In all cases, this includes connections using Microsoft TCP/IP, IPX/SPX-compatible protocol, and NetBEUI in local area networks and TCP/IP in wide area networks.

20.59. NDIS miniport driver makes only NDIS library calls or WDM system calls

Required

A miniport driver must make calls only to the NDIS library or the WDM system. This results in binary compatibility of the driver between Windows 98 and Windows 2000.

NDIS conformance must be validated over a single network connection and multiple connections. For Windows 2000, this must be validated on a multiprocessor system as part of compliance testing.

20.60. NDIS 5.0 driver uses new INF format

Required

All network components must use the INF format defined in the Windows 2000 DDK.

Note: For Windows 2000, there will be no legacy INF support and no satisfactory upgrade option for OEM components created for Windows NT 4.0.

PC 99A clarification: For information about the INF format, see "Chapter 4: Installing Network Components" in "Part 1: Network Drivers" in the "Network Drivers Design Guide" in Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/104install_3l2f.htm).

Network Communications References

The following represents some of the references, services, and tools available to help build hardware that is optimized to work with Windows operating systems.

1997 Version of National ISDN Basic Rate Interface Terminal Equipment Generic Guidelines, Document Number SR-3888
Phone: (800) 521-2673 (North America)
(908) 699-5800 (Outside North America)
http://www.bellcore.com

An Interoperable End-to-End Broadband Service Architecture over ADSL System
http://www.microsoft.com/hwdev/publicnet/

ATM: The New Paradigm for Internet, Intranet & Residential Broadband Services and Applications, T. Kwok
Prentice Hall, 1998; ISBN 0-13-107244-7

ATM User-Network Interface Specification, Version 3.1
Prentice Hall; 1995ISBN 0-13-393828-X
http://www.atmforum.com/atmforum/specs/approved.html

Device Bay Interface Specification, Version 1.0
http://www.device-bay.org

DVB/DAVIC (Digital Video Broadcasting/Digital Audio-Visual Council)
http://www.dvb.org
http://www.davic.org

ETSI (European Telecommunication Standards Institute)
http://www.etsi.fr

Home Phoneline Networking Alliance
http://www.homepna.org

Home Radio Frequency Working Group
http://www.homerf.org

IEEE 802.14 Cable TV Working Group
http://www.walkingdog.com/

ITU (International Telecommunication Union)
http://www.itu.int/publications/index.html

Infrared Extensions to the NDIS Version 4.0 Functional Specification

MCNS *Data-Over-Cable Service Interface Specifications*
http://www.cablemodem.com/

Microsoft Windows 95 DDK, Windows 98 DDK, and Windows 2000 DDK
MSDN Professional subscription

NDIS and Windows networking white papers
http://www.microsoft.com/communications/
http://www.microsoft.com/hwdev/network/

Network Device Class Power Management Reference Specification, Version 1.0a
http://www.microsoft.com/hwdev/specs/PMref/PMnetwork.htm

Network PC System Design Guidelines, Version 1.0b
http://www.microsoft.com/hwdev/netpc.htm
http://developer.intel.com/ial/WfM/design/NETREC.HTM

USB specifications
Phone: (503) 264-0590
Fax: (503) 693-7975
http://www.usb.org/developers/index.html

Checklist for Network Communications

If a recommended feature is implemented, it must meet the requirements for that feature as defined in this document.

Consumer	Office	Mobile	Workstation	Entertainment
20.1. PC system includes network adapter				
Recommended	*Required*	*Recommended*	*Required*	*Recommended*
20.2. PC system includes internal or external ISDN device				
*Recommended**	*Recommended*	*Recommended*	*Recommended*	*Recommended**
20.3. PC system includes cable modem				
*Recommended**	*Recommended*	*Recommended*	*Recommended*	*Recommended**
20.4. PC system includes ATM adapter				
Optional	*Optional*	*Optional*	*Optional*	*Optional*
20.5. PC system includes ADSL adapter				
*Recommended**	*Recommended*	*Recommended*	*Recommended*	*Recommended**
20.6. PC system includes satellite or broadcast receiver with NDIS driver				
*Recommended**	*Recommended*	*Recommended*	*Recommended*	*Recommended**
20.7. Adapter uses NDIS 5.0 miniport driver				
Required				
20.8. Intermediate NDIS 5.0 miniport driver is deserialized				
Recommended				
20.9. Full-duplex adapter automatically detects and switches to full duplex mode				
Required				
20.10. Adapter automatically senses presence of functional network connection				
Required				
20.11. Adapter automatically senses transceiver type				
Required				
20.12. Adapter can transmit packets from buffers aligned on any boundary				
Required				
20.13. Adapter communicates with driver across any bridge				
Required				
20.14. Adapter supports filtering for at least 32 multicast addresses				
Required				
20.15. Adapter and driver support promiscuous mode				
Required				
20.16. Adapter is compatible with remote new system setup capabilities if used as a boot device				
Required				
20.17. PCI network adapters are bus masters				
Required				
20.18. Device Bay-type network adapter meets PC 99 requirements				
Required				
20.19. USB or IEEE 1394 device meets specifications for network communications devices				
Recommended				
20.20. Network adapter and driver supports priority for IEEE 802-style networks				
Recommended				

20.21. Internal ISDN device meets PC 99 network adapter requirements
Required

20.22. Internal ISDN device supports synchronous HDLC framing
Required

20.23. NDIS interface and driver support raw unframed synchronous B channel I/O
Required

20.24. ISDN driver supports unattended installation, with limitations
Required

20.25. ISDN device with U-interface includes built-in NT-1 capability
Recommended

20.26. ISDN device includes software-selectable terminating resistors
Required

20.27. Device is implemented as an integrated cable modem
Recommended

20.28. Integrated cable modem meets PC 99 network adapter requirements
Required

20.29. Integrated cable modem exposes an ATM or Ethernet interface
Required

20.30. ATM adapter meets PC 99 network adapter requirements
Required

20.31. ATM adapter supports a minimum number of simultaneous connections
Required

20.32. ATM adapter supports all service types defined by the ATM Forum
Recommended

20.33. ATM adapter supports UBR service type
Required

20.34. ATM adapter supports a minimum number of simultaneously active VBR or CBR connections
Required

20.35. ATM adapter supports traffic shaping
Required

20.36. ATM adapter enforces PCR on UBR virtual circuits
Required

20.37. ATM adapter and driver support dynamic link speed configuration
Required

20.38. ATM adapter supports OAM
Recommended

20.39. ATM adapter supports buffer chaining (Tx + Rx)
Recommended

20.40. ADSL device is implemented as an integrated ADSL modem
Recommended

20.41. Integrated ADSL modem meets PC 99 network adapter requirements
Required

20.42. ATM/ADSL solution is implemented for integrated ADSL modems
Recommended

20.43. ADSL modem supports DMT line encoding
Recommended

20.44. ADSL modem supports rate adaptation
Recommended

20.45. Infrared device meets PC 99 network adapter requirements
Required

20.46. Infrared device supports both FIR and SIR
Required

20.47. IrDA hardware supports unattended driver installation
Required

20.48. Home networking adapter meets PC 99 network adapter requirements
Required

20.49. Home networking uses appropriate media
Recommended

20.50. Home networking media supports IP
Required

20.51. Each device has a unique Plug and Play device ID
Required

20.52. Dynamic resource configuration is supported for all devices
Required

20.53. Plug and Play capabilities support multiple adapters
Required

20.54. All resource settings are reported in the user interface
Required

20.55. Device complies with device class power management reference specification
Required

20.56. Device supports wake-up events
Required

20.57. Device drivers and installation meet PC 99 requirements
Required

20.58. Driver works correctly with Microsoft network clients and protocols
Required

20.59. NDIS miniport driver makes only NDIS library calls or WDM system calls
Required

20.60. NDIS 5.0 driver uses new INF format
Required

Note: For items marked with an asterisk (*) symbol, it is recommended to implement an ADSL modem, ISDN device, or home networking adapter.