Lecture "Telekommunikationstechnik"

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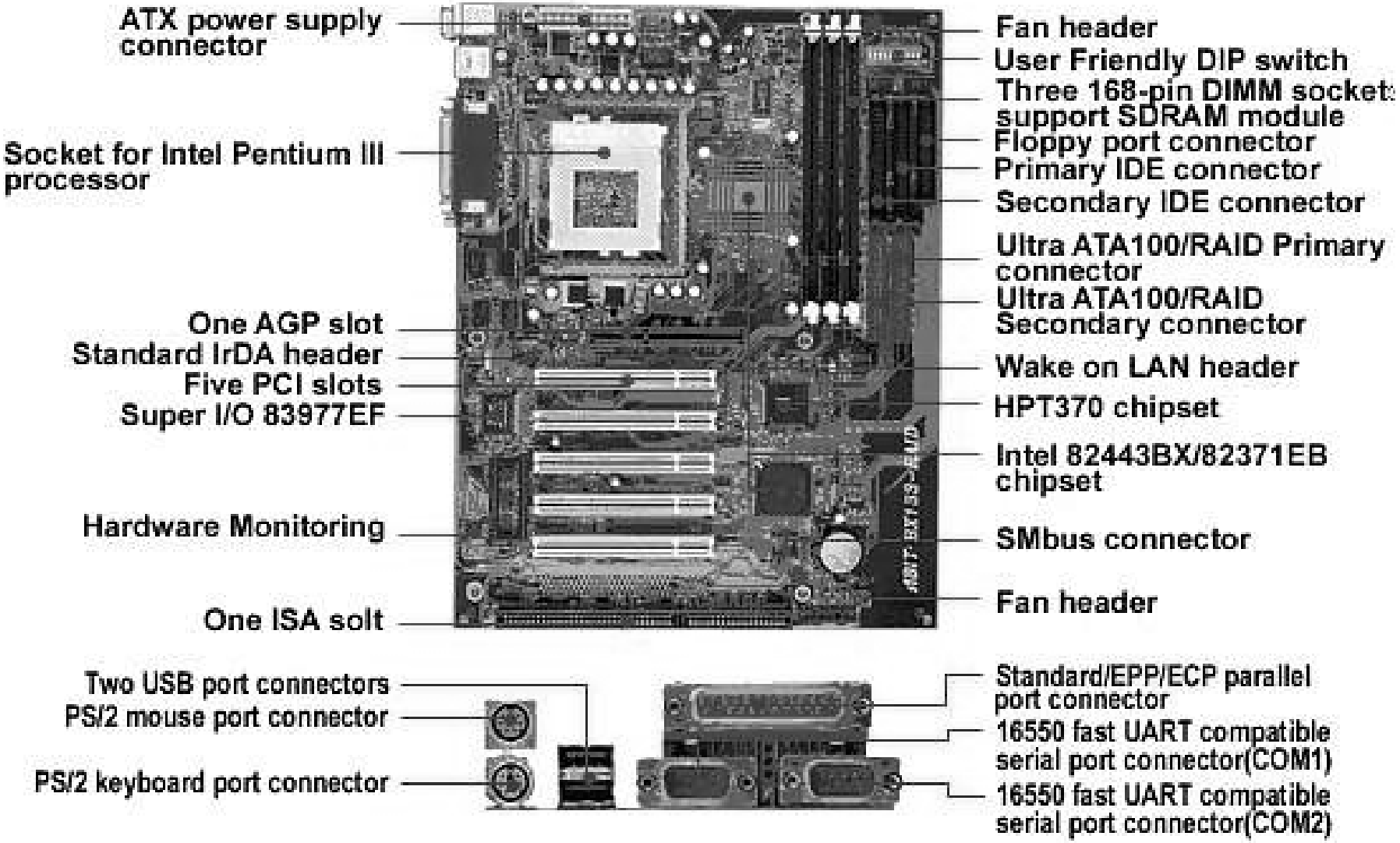
Objectives

- The physical connection of a computer to the Internet
- The primary components of a computer
- Installation and troubleshooting network interface cards and/or modems
- Basic testing procedures to test the Internet connection
- Web browser selection and configuration
- The Base 2 number system
- Binary number conversion to decimal
- The hexadecimal number system
- Binary representation of IP addresses and network masks
- Decimal representation of IP addresses and network masks

PC Basics - Motherboard



Network Interface Card

When selecting a NIC, consider the following factors:

- **Protocols** – Ethernet, Token Ring, or FDDI
- **Types of media** – Twisted-pair, coaxial, wireless, or fiber-optic
- **Type of system bus** – PCI or ISA

NIC and Modem Installation

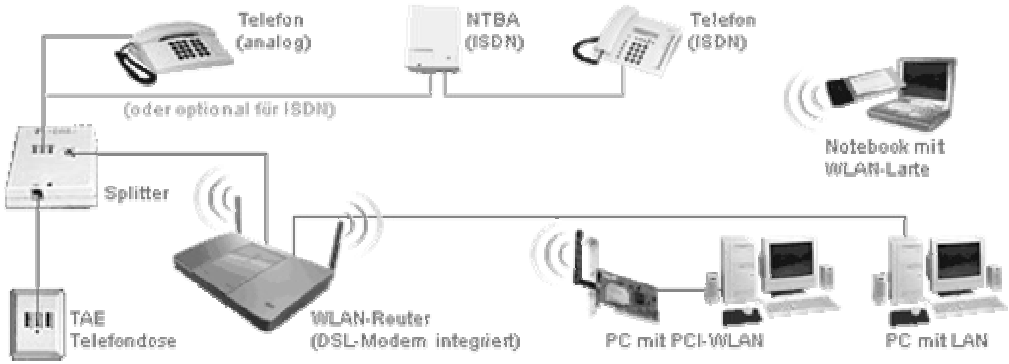
- A **modem**, or **mo**dulator-**dem**odulator, is a device that provides the computer with connectivity to a telephone line.
- PCMCIA wired and wireless NICs.
- Desktop systems may use an internal or external NIC.

Overview of High-Speed and Dial-Up Connectivity

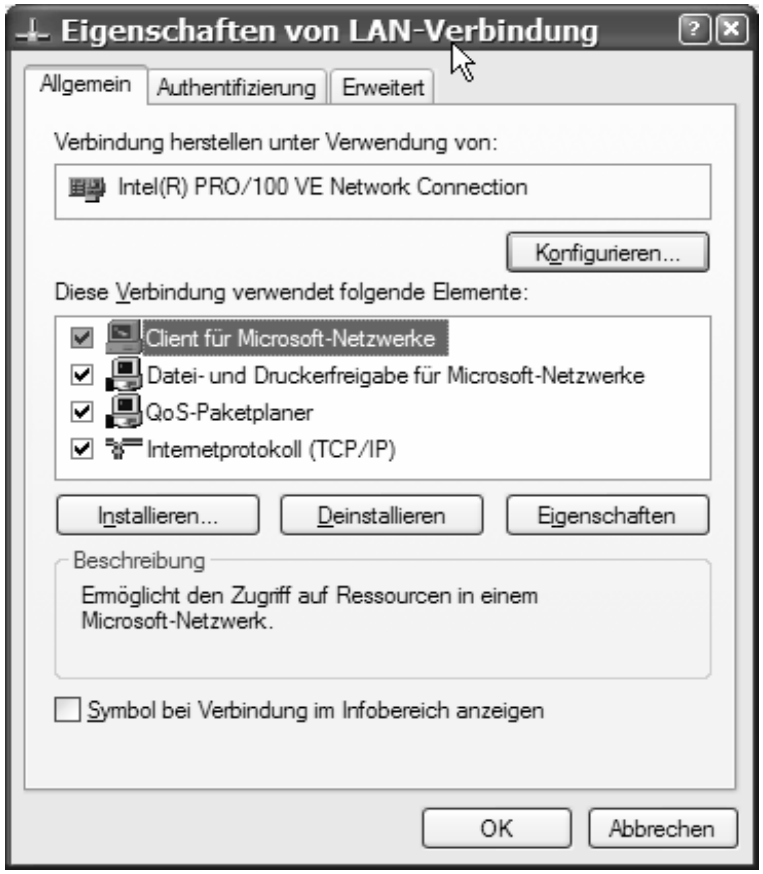
Connectivity Overview

- In early 1960s, modems were introduced to provide connectivity for dumb terminals to a centrally based computer
- In 1970s, BBS allowed users to connect and post or read messages on a discussion board
- In 1980s, the transfer of files and graphics became desirable
- In 1990s, modem speed increased up to 56 kbps
- In 2000, high-speed services became desirable

- High-speed services such as **D**igital **S**ubscriber **L**ine (**DSL**) and cable modem access, are in common use today.
- These services **no longer require** expensive equipment or a **second phone line**.
- These are "**always on**" services that provide instant access and do not require a connection to be established for each session.
- This gives greater reliability and flexibility, and has led to the ease of Internet connection sharing by **s**mall **o**ffice and **h**ome **o**ffice (**SOHO**) **networks**.



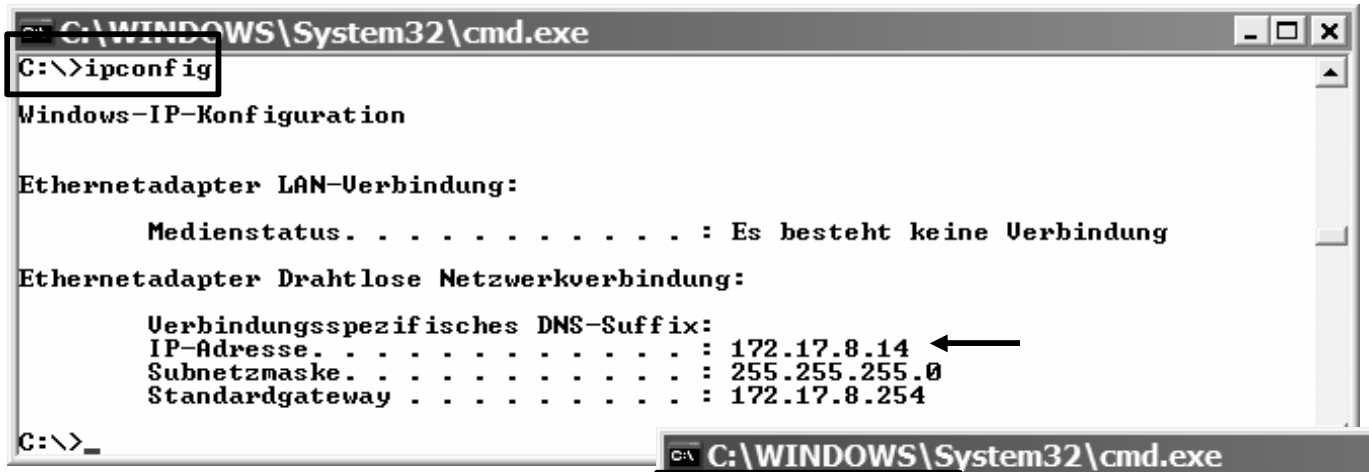
TCP/IP Description and Configuration

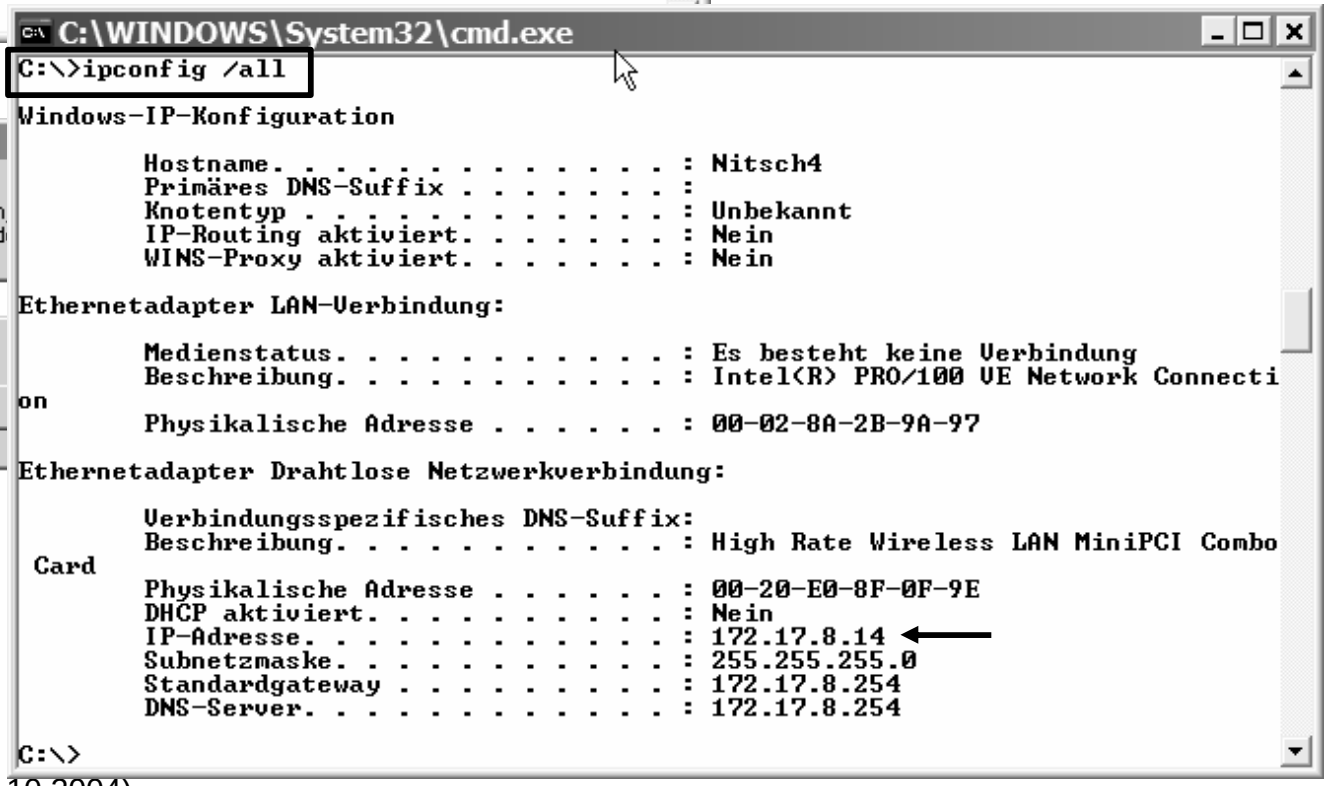


- The network OS is part of the PCs OS.
- Transmission Control Protocol/Internet Protocol Suite (TCP/IP) is a set of protocols developed to allow cooperating computers to share resources across a network.
- TCP/IP is implemented in the OS of the PC.
- **TCP/IP needs to be configured** using operating system tools

Verify IP Configuration ⇒

Verify IP Configuration: Win XP, NT, 2000





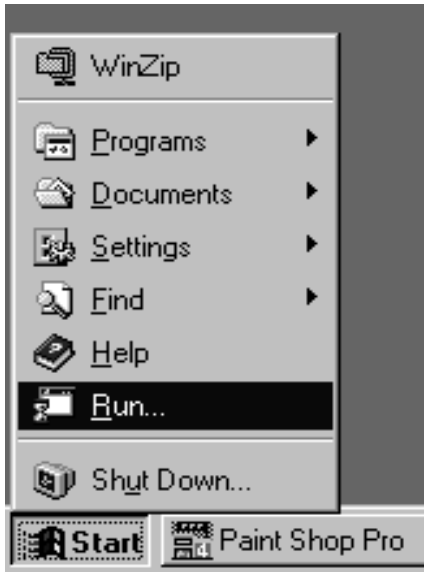
Exercise: Write down the IP addresses of your

- host
- standardgateway
- DNS server
- neighbors host

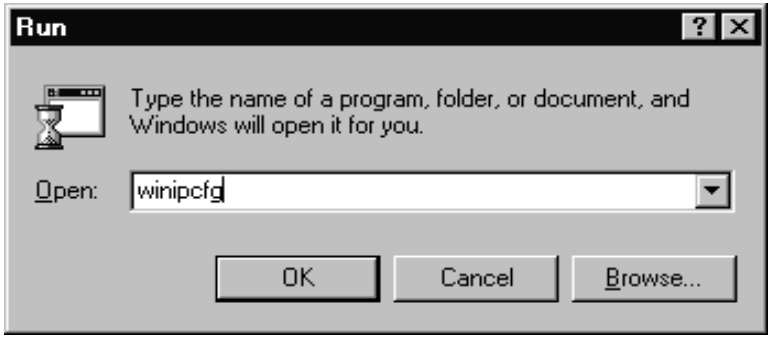
You will need them later!

Verify IP Configuration: Win 9x

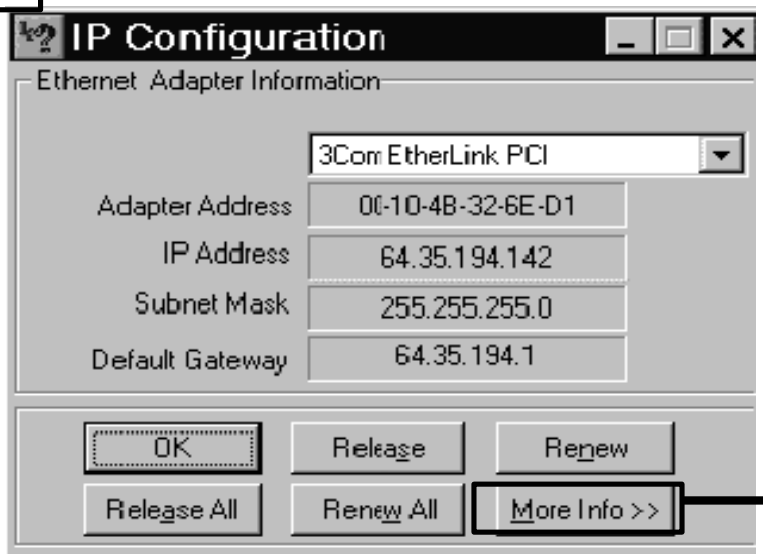
1



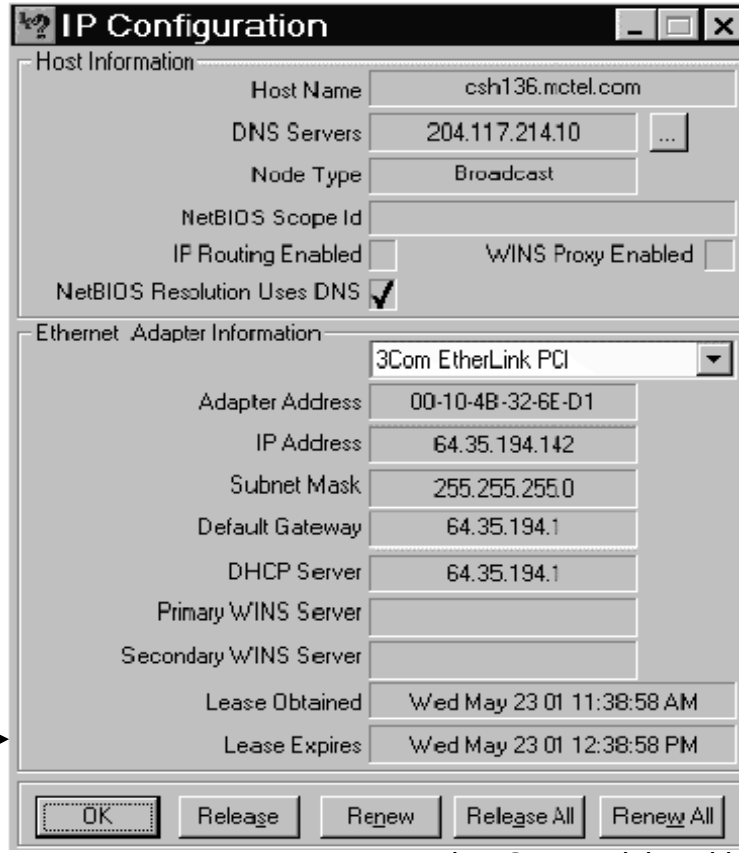
2



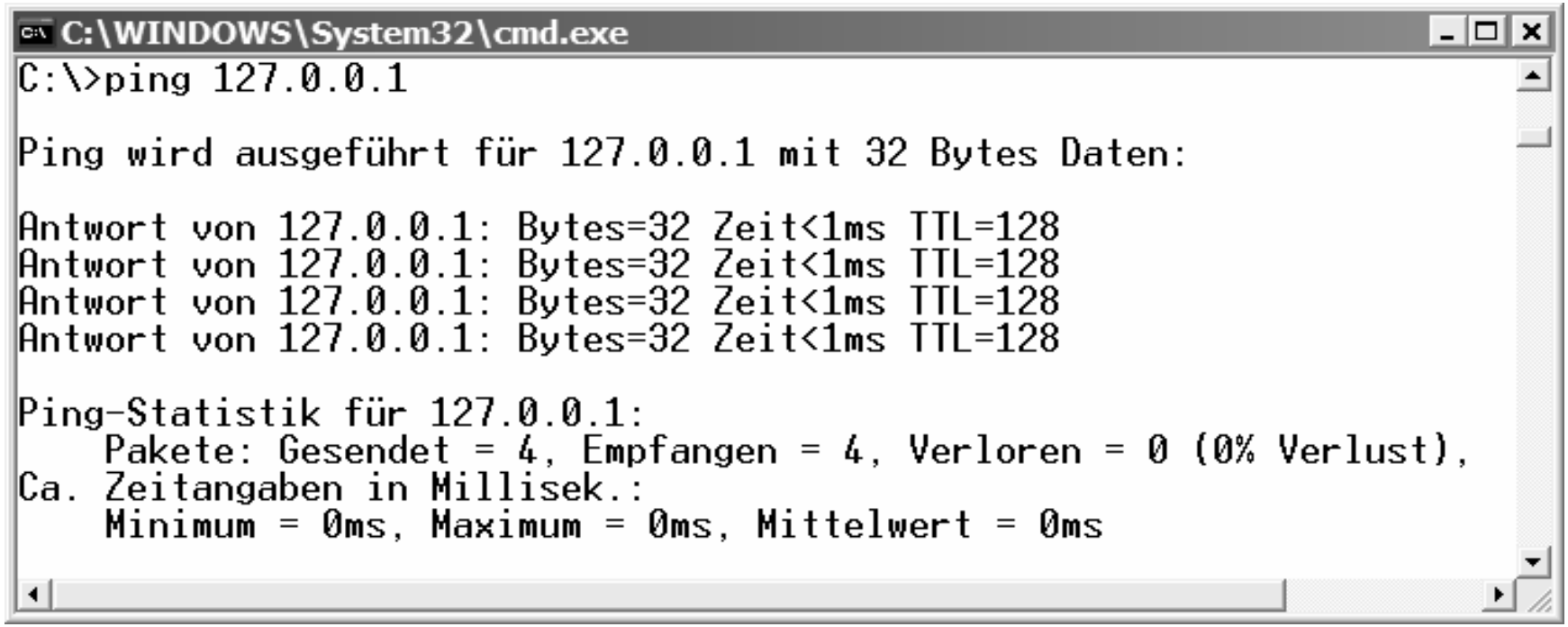
3



4



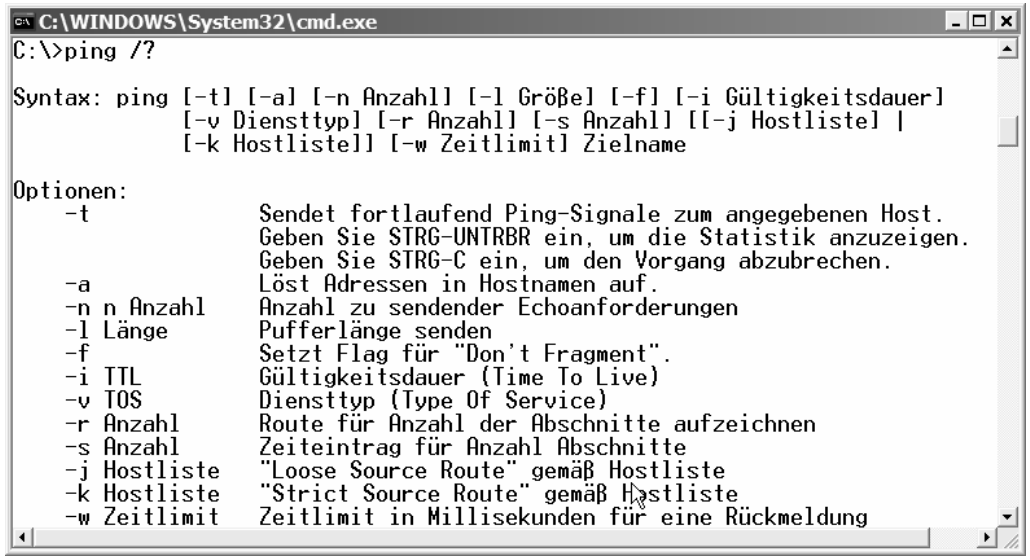
Testing Connectivity with Ping



- The **`ping` command works by** sending multiple IP data packets to a specified destination host. Each packet sent is a **request** for a reply. The receiving host answers with a **reply** data packet. The underlying **request-reply concept** is used by most computer communication.
- The **`ping`** command is used to test wether the destination host is up, the NIC transmit/receive function, the TCP/IP configuration, and network connectivity.

Testing Connectivity with Ping

- **ping** ***127.0.0.1*** - This ping is unique and is called an internal loopback test. It verifies the operation of the TCP/IP stack and NIC transmit/receive function.
- **ping** *IP address of host computer* - A ping to a host PC verifies the TCP/IP address configuration for the local host and connectivity to the host.
- **ping** *default-gateway IP address* - A ping to the default gateway verifies whether the router that connects the local network to other networks can be reached.
- **ping** *remote destination IP address* - A ping to a remote destination verifies connectivity to a remote host.
- ping cannot
  - verify wether an Email address is valid
  - check a specific web page

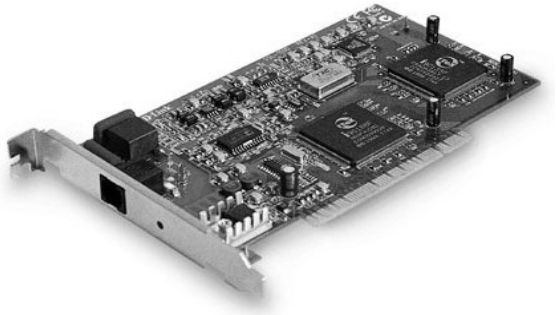


Ping exercises:

1. ping to internal loopback address
2. ping your host's IP address
3. ping your neighbors IP address
4. ping your gateway's IP address
5. ping your DNS's IP address

Ethernet Networks

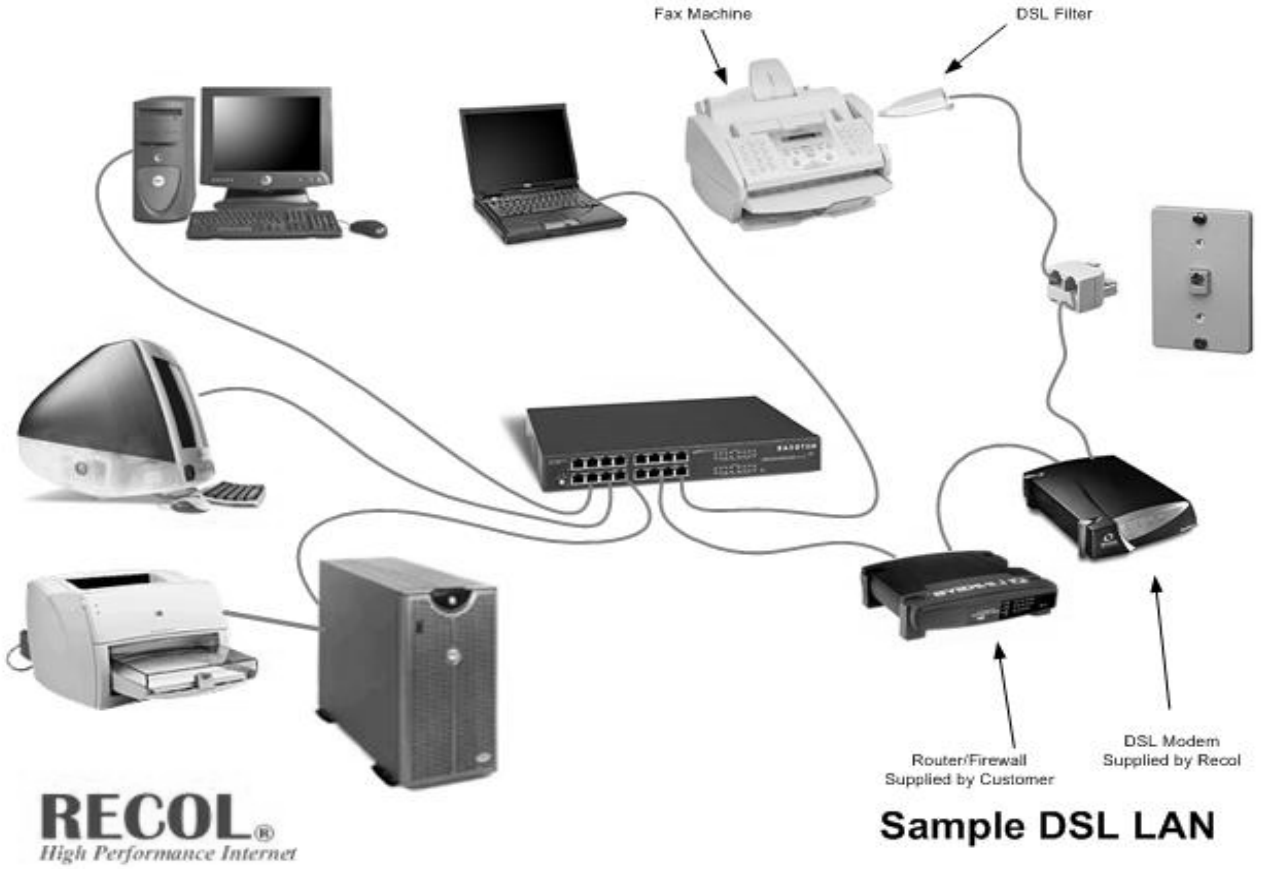
- Most Local Area Networks (LANs) use the Ethernet protocol.
- Each Ethernet Network Interface Card (NIC) has an "**Ethernet Address**".
- Yes, computers have two addresses: Ethernet Address and an IP Address



```
C:\WINDOWS\System32\cmd.exe
C:\>ipconfig /all

Windows-IP-Konfiguration

        Hostname. . . . . . . . . . . . . : Nitsch4
        Primäres DNS-Suffix . . . . . . . :
        Knotentyp . . . . . . . . . . . . : Unbekannt
        IP-Routing aktiviert. . . . . . . : Nein
        WINS-Proxy aktiviert. . . . . . . : Nein

Ethernetadapter LAN-Verbindung:

        Medienstatus. . . . . . . . . . . : Es besteht keine Verbindung
        Beschreibung. . . . . . . . . . . : Intel(R) PRO/100 VE Network Connecti
on
        Physikalische Adresse . . . . . . : 00-02-8A-2B-9A-97

Ethernetadapter Drahtlose Netzwerkverbindung:

        Verbindungsspezifisches DNS-Suffix:
        Beschreibung. . . . . . . . . . . : High Rate Wireless LAN MiniPCI Combo
 Card
        Physikalische Adresse . . . . . . : 00-20-E0-8F-0F-9E
        DHCP aktiviert. . . . . . . . . . : Nein
        IP-Adresse. . . . . . . . . . . . : 172.17.8.14
        Subnetzmaske. . . . . . . . . . . : 255.255.255.0
        Standardgateway . . . . . . . . . : 172.17.8.254
        DNS-Server. . . . . . . . . . . . : 172.17.8.254

C:\>
```

- So, how is an Ethernet Address used?

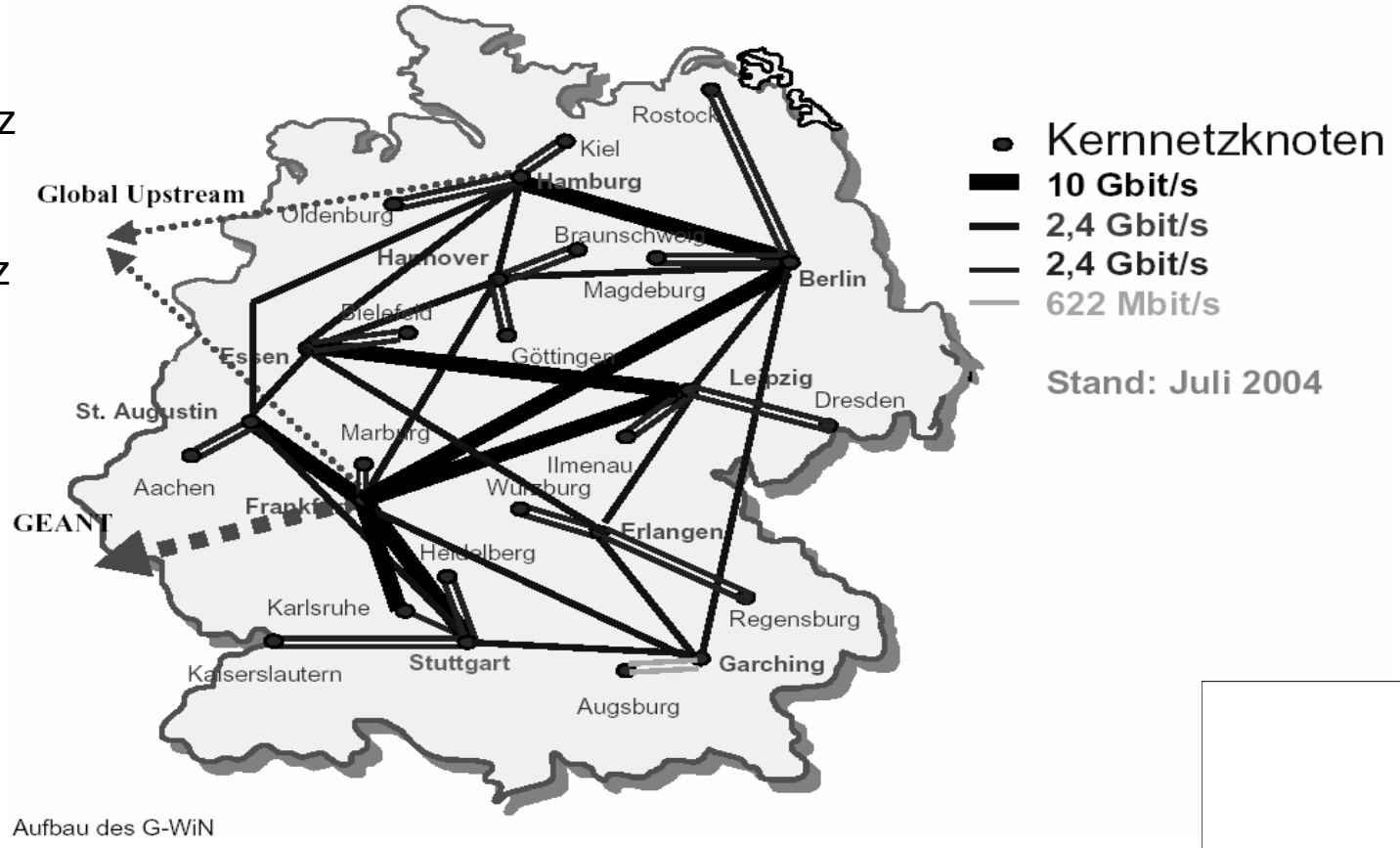
Ethernet Networks



- **Hubs** and **Switches** connect Ethernet devices on the same LAN.
- Routers connect LANs together over WANs (**Wide Area Networks**).

WANs (Wide Area Networks)

WAN - Beispiel: G-WiN
Das Deutsche Forschungsnetz (DFN) ist das von der Wissenschaft selbst verwaltete Hochleistungsnetz für Wissenschaft und Forschung in Deutschland. Es **verbindet Hochschulen** und Forschungseinrichtungen miteinander. Der nationale Backbone des DFN ist das Gigabit-Wissenschaftsnetz G-WiN. Über den europäischen Backbone GÉANT ist das G-WiN mit dem weltweiten Verbund der Forschungs- und Wissenschaftsnetze direkt verbunden.



Aufbau des G-WiN

http://www.dfn.de

Ethernet Networks

- How is the Ethernet address used?
- The IP packet is put inside an Ethernet frame.
- The Ethernet source address (**MAC address**) is your computer.
- If the two computers are on the same LAN (**Local Area Network**) then the destination MAC address is the other computer.
- If the two computers are on different LANs then the destination MAC address is that of the router.
- Much more later …

FH-Darmstadt

Inside the packet

172.16.22.73

Source IP address

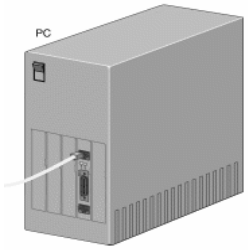
216.109.125.69

Destination IP address

Inside the Ethernet Frame

00-20-E0-6B-17-62

Source Ethernet address



00-02-b3-4b-a1-e6

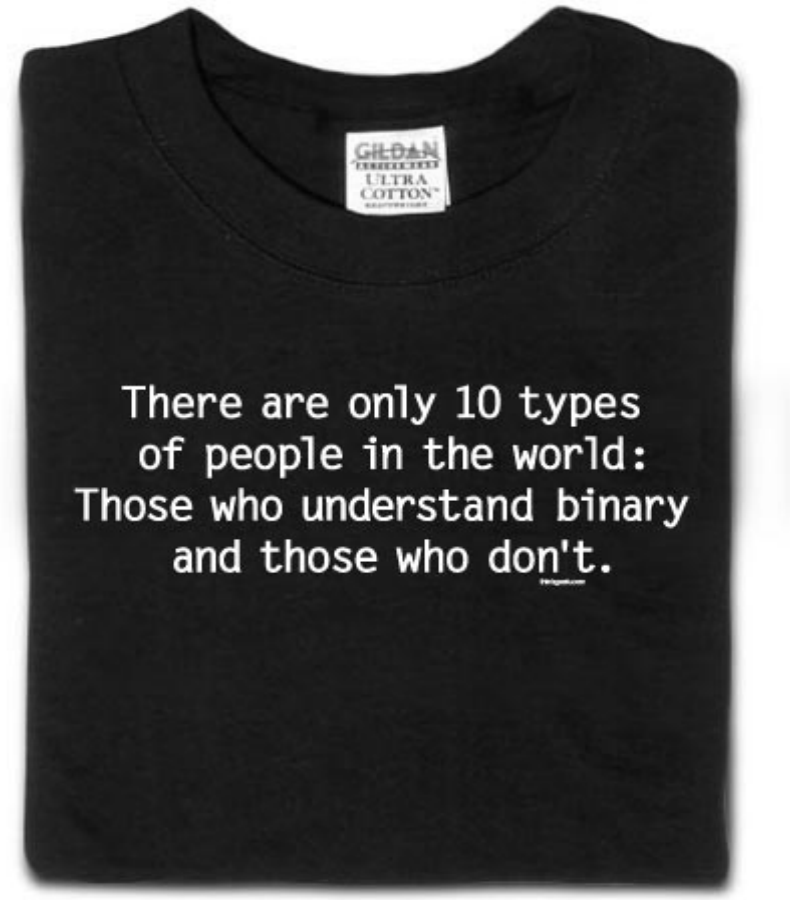
Destination Ethernet address

Web Browser and Plug-ins

Plug-in applications

- These applications work in conjunction with the browser to launch the program required to view the following special files:
- **Flash** – plays multimedia files (animation, interactions, sound); created by Macromedia Flash
- **Quicktime** – plays video files; created by Apple
- **Real Player** – plays audio & video files
- Technique & plug-in test: http://www.vs-c.de/technik/index.html

Network Math



www.thinkgeek.com

Binary Presentation of Data

- The **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange (ASCII) is the most commonly used code for representing alpha-numeric data in a computer.

ASCII Chart

							0	1	0	1	1	0	0	1
							0	0	1	1	1	1	0	0
1	2	3	4	5	6	7	1	1	1	1	0	0	0	0
0	0	0	0				@	P	'	p	0	sp	NUL	DLE
1	0	0	0				A	Q	a	q	1	!	SOH	DC1
0	1	0	0				B	R	b	r	2	"	STX	DC2
1	1	0	0				C	S	c	s	3	#	ETX	DC3
0	0	1	0				D	T	d	t	4	$	EOT	DC4
1	0	1	0				E	U	e	u	5	%	ENQ	NAK
0	1	1	0				F	V	f	v	6	&	ACK	SYN
1	1	1	0				G	W	g	w	7	'	BEL	ETB
0	0	0	1				H	X	h	x	8	(	BS	CAN
1	0	0	1				I	Y	i	y	9	)	HT	EM
0	1	0	1				J	Z	j	z	:	*	LF	SUB
1	1	0	1				K	[	k	{	;	+	VT	ESC
0	0	1	1				L	\	l	|	<	,	FF	FS
1	0	1	1				M	]	m	}	=	-	CR	GS
0	1	1	1				N	^	n	~	>	.	SO	RS
1	1	1	1				O	_	o	?	?	/	SI	US

- ASCII code chart:
  http://www.jbase.com/knowledgebase/manuals/3.0/30manpages/man/AsciiChart.htm
- Data Representation and Number Systems:
  http://scholar.hw.ac.uk/site/computing/_subindex_f1ncomp5topic1.html

Bits and Bytes

Units	Definition	Bytes*	Bits*	Examples
Bit (b)	Binary digit, a 1 or 0	1	1	On/Off; Open/Closed +5 Volts or 0 Volts
Byte (B)	8 bits	1	8	Represent the letter "X" as ASCII code
Kilobyte (KB)	1 kilobyte = 1024 bytes = 2^{10} bytes	1000	8,000	Typical Email = 2 KB 10-page report = 10 KB Early PCs = 64 KB of RAM
Megabyte (MB)	1 megabyte = 1024 kilobytes = 1,048,576 bytes = 2^{20} bytes	1 million	8 million	Floppy disks = 1.44 MB Typical RAM = 32 MB CDROM = 650 MB
Gigabyte (GB)	1 gigabyte = 1024 megabytes =1,073741,824 bytes = 2^{30} bytes	1 billion	8 billion	Typical Hard Drive = 40 GB or greater
Terabyte (TB)	1 terabyte = 1024 gigabytes = 1,099,511,627,778 bytes = 2^{40} bytes	1 trillion	8 trillion	Amount of data theoreti- cally transmittable in optical fiber in one second

Base 10 Number System

Place Value	1000 100 10 1
Base$^{\text{Exponent}}$	$10^3 = 1000$ $10^2 = 100$ $10^1 = 10$ $10^0 = 1$
Number of Symbols	10
Symbols	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Rationale	Typical number of fingers equals ten

- The decimal number system is based on powers of 10.
- Each column position of a value, from right to left, is multiplied by the number 10, which is the base number, raised to a power, which is the exponent.
- The power that 10 is raised to depends on its position to the left of the decimal point.
- $2134 = (2x10^3) + (1x10^2) + (3x10^1) + (4x10^0)$

Base 2 Number System

Place Value	128 64 32 16 8 4 2 1
Base^{Exponent}	$2^7 = 128$ $2^3 = 8$ $2^6 = 64$ $2^2 = 4$ $2^5 = 32$ $2^1 = 2$ $2^4 = 16$ $2^0 = 1$
Number of Symbols	2
Symbols	0, 1
Rationale	Two-state (discrete binary) voltage systems made from transistors can be diverse, powerful, inexpensive, tiny and relatively immune to noise.

- $10110_2 = (1 \times 2^4 = 16) + (0 \times 2^3 = 0) + (1 \times 2^2 = 4) + (1 \times 2^1 = 2) + (0 \times 2^0 = 0) = 22$ (16 + 0 + 4 + 2 + 0)

Binary to Decimal Conversion

- Binary

$$10101_2$$

- to decimal

$$10101_2$$

$$= 1 \cdot 2^4 \; +0 \cdot 2^3 \; +1 \cdot 2^2 \; +0 \cdot 2^1 \; +1 \cdot 2^0$$

$$= 16 \quad +0 \quad +4 \quad +0 \quad +1$$

$$= 21$$

Exercise:

Homework

$$11001101_2 =$$

$$11011101_2 =$$

$$01010101_2 =$$

Decimal to Binary Conversion

Position	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1
to Binary	1	1	0	0	1	1	1	1
to decimal	128	+64	+0	+0	+8	+4	+2	+1

= 207

128	207
	128
64	79
	64
8	15
	8
4	7
	4
2	3
	2
	1

Umwandlung einer Dezimalzahl in eine Binärzahl

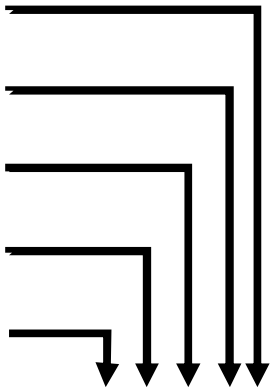
- Rekursives Teilen durch 2 bis Ergebnis = 0. Divisionsreste (Modulo 2) ergeben rückwärts geschrieben die Binärzahl

- Dezimalzahl

$$21_{10}$$

- Binärzahl

$$21/2 = 10 \quad \text{Rest } 1$$
$$10/2 = 5 \quad \text{Rest } 0$$
$$5/10 = 2 \quad \text{Rest } 1$$
$$2/2 = 1 \quad \text{Rest } 0$$
$$1/2 = 0 \quad \text{Rest } 1$$



- Aufgaben:

$$21_{10} = 10101$$

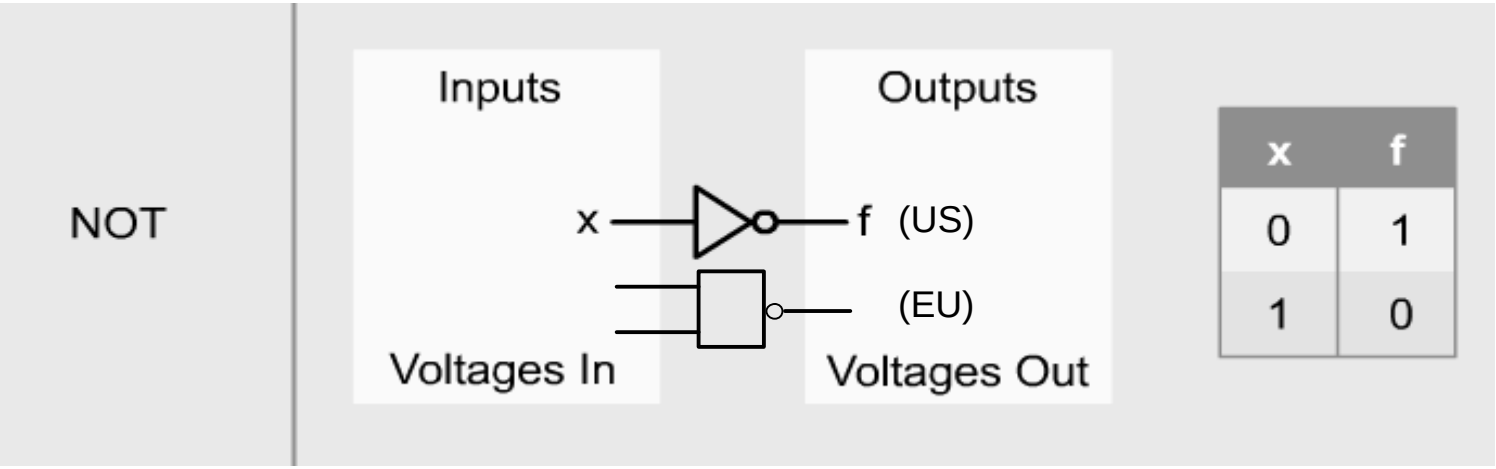
$$221_{10} =$$
$$186_{10} =$$
$$109_{10} =$$

Four-Octet Dotted Decimal Representation of 32-bit Binary Numbers

Binary	11001000		01110010		00000110		00110011
Decimal	200	.	114	.	6	.	51
	number	dot	number	dot	number	dot	number

- Currently, IP addresses assigned to computers on the Internet are 32-bit binary numbers (IPv4).
- This means, there are about one address per inhabitant on earth.
- To make it easier to work with these addresses, the 32-bit binary number is broken into a series of 4 decimal numbers, separated by dots (dotted decimal representation).
- To do this, split the binary number into four groups of eight binary digits.
- Then convert each group of eight bits, also known as an octet into its decimal equivalent.

Boolean or Binary Logic

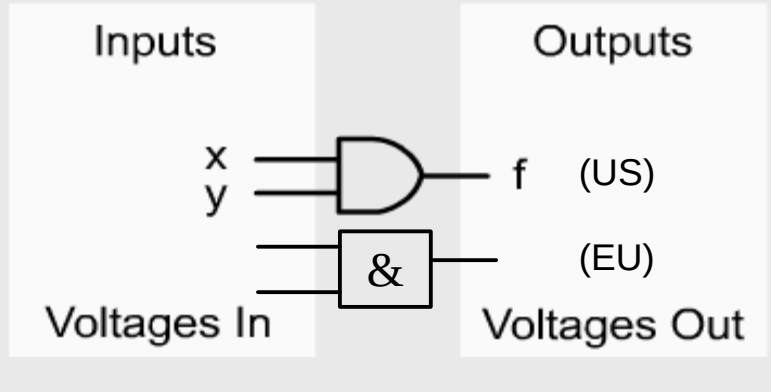


x	f
0	1
1	0

- Boolean logic is based on digital circuitry that accepts one or two incoming voltages.
- Based on the input voltages, output voltage is generated. For the purpose of computers the voltage difference is associated as two states, on or off.
- These two states are in turn associated as a 1 or a 0, which are the two digits in the binary numbering system.

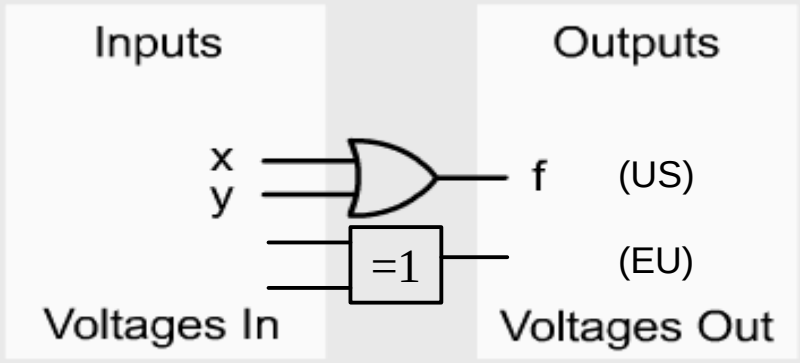
Boolean or Binary Logic

AND



x	y	f
0	0	0
0	1	0
1	0	0
1	1	1

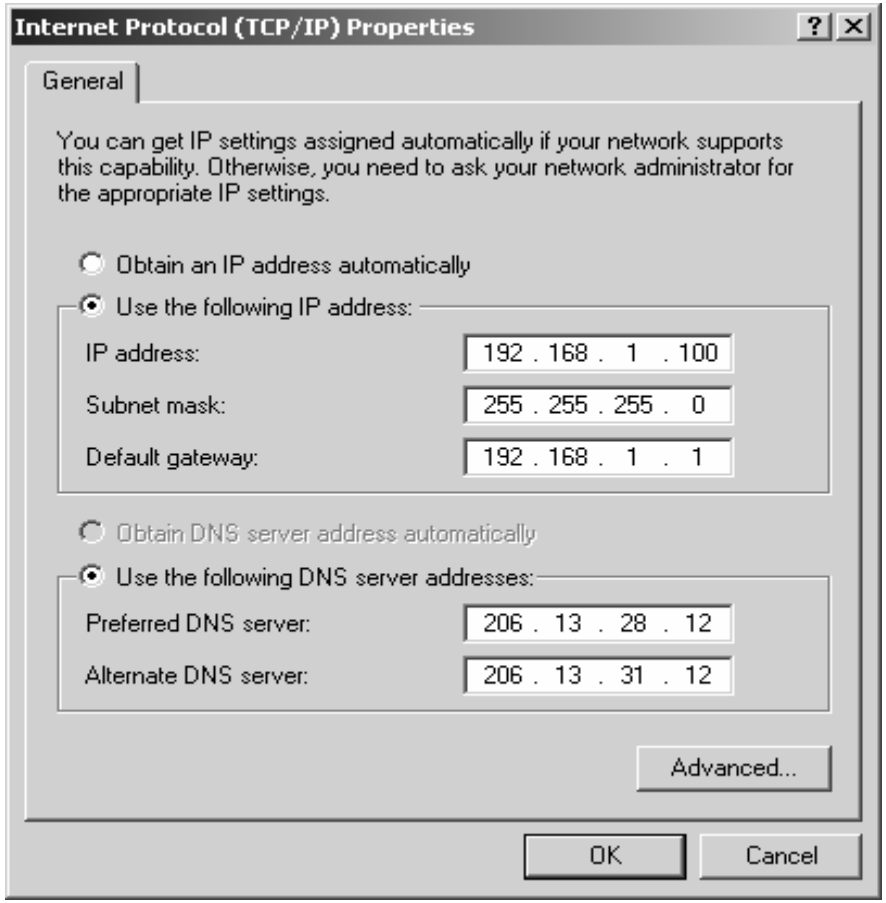
OR



x	y	f
0	0	0
0	1	1
1	0	1
1	1	1

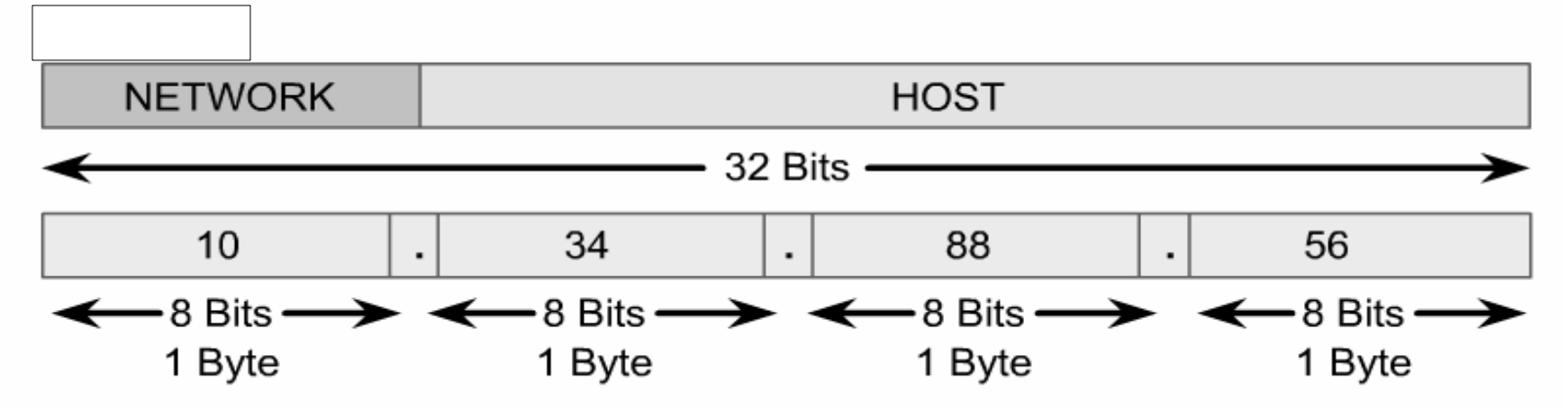
IP addresses and network masks

- IP addresses have a hierarchical structure: The 32-bit IP address is subdivided into a **network part** and a **host part**.
- A **subnet mask** informs a computer how the 32-bit IP address has been split.
- A subnet mask will always be all 1s starting from the left most bit until the **network address** is identified and then be all 0s from there to the right most bit of the mask.
- The bits in the subnet mask that are 0 identify the computer or **host address** on that network.



255	.	255	.	255	.	0
11111111		11111111		11111111		00000000

IP Addresses and Network Masks



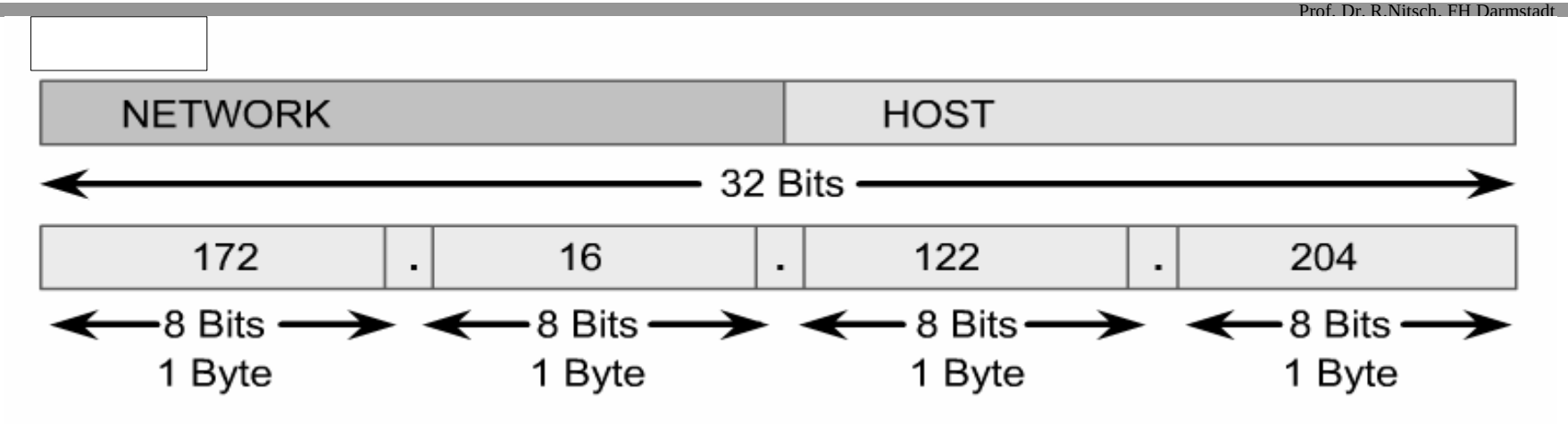
- Performing a Boolean AND of the IP address 10.34.23.134 and the subnet mask 255.0.0.0 produces the network address of this host:

10.34.23.134	00001010.00100010.00001011.10000110
255.0.0.0	11111111.00000000.00000000.00000000
10.0.0.0	00001010.00000000.00000000.00000000

x	y	&
0	0	0
0	1	0
1	0	0
1	1	1

- Converting the result to dotted decimal, 10.0.0.0 is the network portion of the IP address, when using the 255.0.0.0 mask.
- **The host with the IP address of** 10.34.23.134 **is a member of the** 10.0.0.0 **network.**

IP Addresses and Network Masks



- Performing a Boolean AND of the IP address 172.16.122.204 and the subnet mask 255.255.0.0 produces the network address of this host:

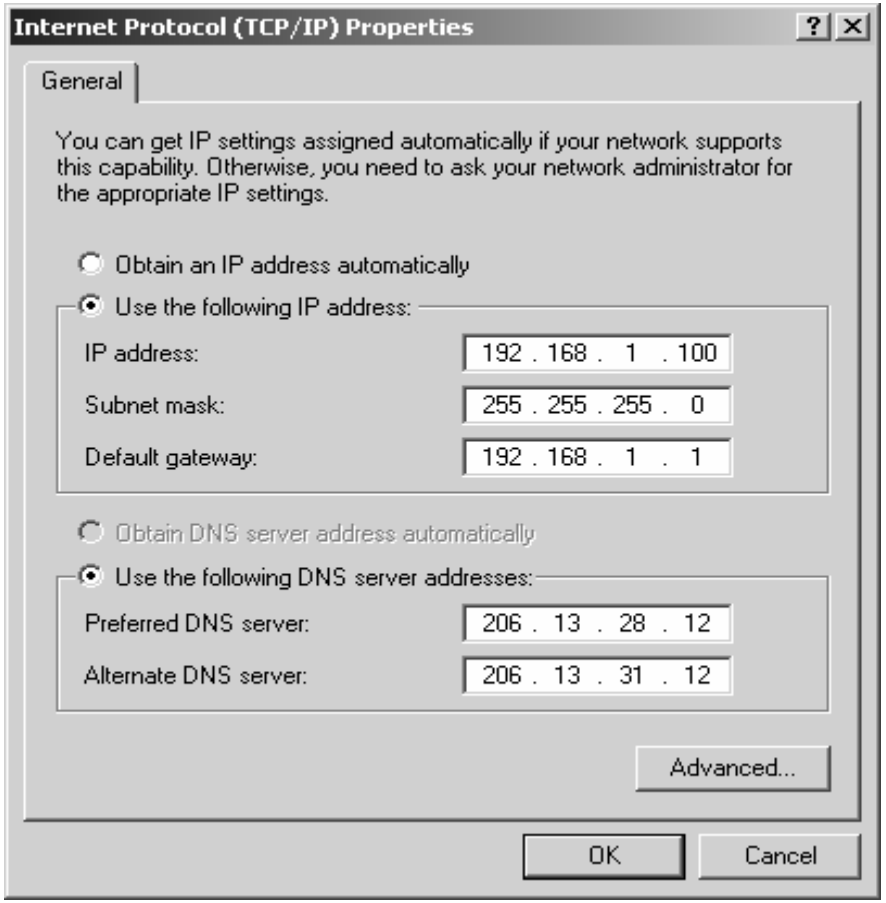
172.16.122.204	10101100.00010000.01111010.11001100
255.255.0.0	11111111.11111111.00000000.00000000
172.16.0.0	10101100.00010000.00000000.00000000

x	y	&
0	0	0
0	1	0
1	0	0
1	1	1

- Converting the result to dotted decimal, 172.16.122.0 is the network portion of the IP address, when using the 255.255.0.0 mask.
- **The host with the IP address of** 172.16.122.204 **is not a member of the computers** 192.168.1.0 **network. Data packets with this destination address are sent to the gateway.**

IP Addresses and Network Masks

- What is the network address?
- Is the default gateway on the same network?
- What does the IP address and subnet mask tell you and your computer?



Lab Exercises

Lab 1.1.6 Lab Exercise: PC Network TCP/IP Configuration
In this lab, the student will identify tools used to discover a computer network configuration with various operating systems.

Lab 1.1.7 Lab Exercise: Using ping and tracert from a Workstation
In this lab, the student will learn to use the ping command and the Traceroute (tracert) command from a workstation

Lab 1.2.5 Lab Exercise: Decimal to Binary Conversion
In this lab, the student will learn and practice to convert decimal values to binary values.

Lab 1.2.6 Lab Exercise: Binary to Decimal Conversion
In this lab, the student will learn and practice the process of converting binary values to decimal values.

Summary

- Three requirements for an Internet connection are a physical connection, a logical connection, and a web browser.
- Computers recognize and process data using a binary numbering system.
- The number system used most frequently is the decimal number system.
- The hexadecimal number system is used when working with computers because it can be used to represent binary numbers in a more readable form.

An understanding of the following key points should have been achieved:

- The physical connection that has to take place for a computer to connect to the Internet
- The primary components of a computer
- Installation and troubleshooting network interface cards and/or modems
- Basic testing procedures to test the Internet connection
- Web browser selection and configuration
- The Base 2 number system
- Binary number conversion to decimal
- Binary representation of IP addresses and network masks
- Decimal representation of IP addresses and network masks