LESSON E2_EN. STUDYING THE INTERNET TCP/IP THROUGH PRACTICAL EXPERIMENTS. TROUBLESHOOTING THE NETWORK. IPCONFIG. TRACERT. HOSTNAME. NETWORKING MEASUREMENT UNITS.

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After studying this lesson, you will acquire the following knowledge:

- Understanding the principal elements of Internet functioning based on your own practice.
- Applying important Internet diagnosis tools: Tracert and IPConfig.
- Important Tracert's features, versions and conditions of use. Troubleshooting with Tracert.
- Important elements of the TCP/IP suite of protocols,
- Using important debugging and troubleshooting tools, Tracert and IPConfig.
- Understanding the Internet and the essential elements of TCP/IP protocols, based on these diagnosis tools.
- Acquiring the networking measurement units

CONTENT OF THE LESSON

LEARNING OBJECTIVES:

After learning this lesson you will acquire the abilities to:

- understand the elements of Internet functioning, based on your own practical experiments
- use the important and powerful diagnosis tools Tracert and IPConfig in different versions and for various purposes,
- test and diagnose the Ethernet and Internet networks with important diagnosis tools: Tracert and IPConfig,
- diagnose and find important and frequent troubles in different configurations of the Internet network,
- consolidate the knowledge about connection-less Data transmission through practical experiments,
- become an Internet practitioner and technician from your first lessons on Internet practice,
- know, understand and use the networking measurement units.

1. ESSENTIAL FEATURES OF THE TCP/IP SUITE OF PROTOCOLS.

1. Connection-oriented and connectionless Data transmission.

There are two main systems for Data transmission:

- Connection-oriented (such as ATM - Asynchronous Transfer Mode) which maintains the line connected between two points (even the line may be replaced), and
- connectionless, such as the Internet, in which the line is not busy during the communication process. In the connectionless systems, the Data Packet cooperates with the Routers in order to find the path based on the IP Address.

Your experiments have illustrated that the Internet functions based on the commutation of Data Packets and not by the commutation of the lines.
That is why the Internet communication is cheaper than using pre-established lines. The time when these lines are busy is shorter with connectionless systems (the Packets switching as in the Internet) than in the line switching systems (line oriented systems).

In order to work with Data packets, the packets must find the path from source to Destination.

In selecting the path, the Data Packet uses the IP Address. The IP Address is a virtual address allocated to each partner of the networking and to each device connected to the Internet.
The header of each packet includes the IP Address of the Destination device and the IP Address of the Source device (as well as other information).

The Data packets are achieved based on a TCP/IP suite of protocols
The TCP/IP suite of protocols is present in each machine, including your machine. All processes involving the Internet are achieved based on these TCP/IP protocols.

- The TCP/IP protocols are very flexible. They may be used for most of the technology for Data transfers.
- Computers, called Routers, direct Data Packets on the path.
- Routers are not necessary in single physical networks.
- The TCP/IP protocols use the principle of device separation: the Routers send Data Packets to the networks, not to the devices. The Routers do not know the destination of the Data Packets or their path, they only know which is the next network along the path towards which the Packets are distributed.
- All the networks are equally treated by the TCP/IP.

Internet Services most frequently used:

- From the point of view of applications, the Internet Services most frequently used (all based on the TCP/IP) are: www – the World Wide Web, e-mail, File Transfer, Remote Login and Remote Desktop.
- From the point of view of the network, the important Internet Services are:
  - Connectionless Packet Delivery Service: the delivery of Data packets based on the use of IP Addresses.
  - Reliable Stream Transport Service: establishing a virtual connection and transferring a large amount of Data.
  - Diagnosis Services
  - Others.

The diagnosis services stand as one of the main reasons why the Internet has proved a success.
The diagnosis tools Ping, Tracert, IPConfig - used by the Internet technicians on a daily basis - represent an important part of the success of the Internet.

2. CONNECTING THE MACHINE IN LAN AND TO THE INTERNET.

The base of the Internet is the LANs - Local Area Networks. Most of the LANs function on the Ethernet protocol.
The configuration of a LAN in which you may be integrated is illustrated in fig.2.1.
The LAN is connected to the Internet through the Gateway in a bidirectional way.

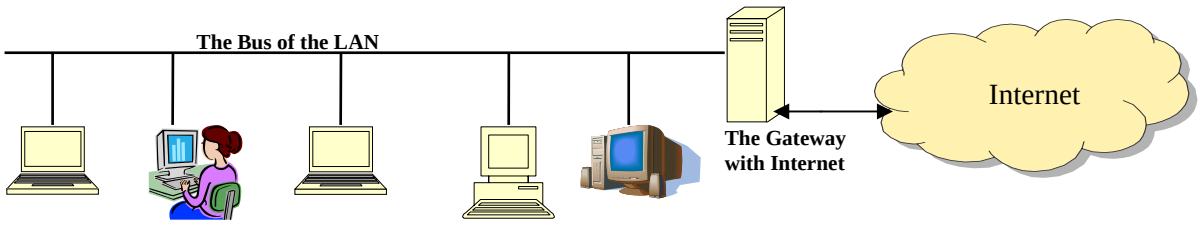

Fig. 2.1. The LAN and the Gateway towards the Internet

Based on TCP/IP protocols, you may communicate only in LANs or through the Gateway with the entire Internet world.
The LAN is based on Ethernet protocols. The TCP/IP suite of protocols includes the Ethernet protocols.
The small architecture, illustrated in fig. 2.1., is one of a typical configuration of working in a LAN (or through a LAN) with the entire Internet.
The configuration belongs to bus-architectures, many types of the interconnection architectures being used in networking.

3. IPConfig - THE INTERNET TOOL MOST FREQUENTLY USED (IN MS WINDOWS) FOR THE IDENTIFICATION OF THE INTERNET PARAMETERS OF YOUR MACHINE.

1.) The IPConfig Debugging tool.
IPConfig is an important tool for solving network problems.

The IPConfig is so important because in the debugging and troubleshooting process, it is necessary to know the following addresses:

- the IP Address of your machine,
- the IP Address of the Gateway viewed form the side of your machine,
- the IP Addresses of the DNS Severs containing the tables of the world correspondence between the DNS addresses and the IP Addresses. This correspondence is necessary for navigation, because the persons usually navigate to the DNS addresses and the network, while Data packets work only with IP Addresses.
  The process of address resolution is also necessary for other activities, for instance when the diagnosis tools Ping or Tracert are targeted to DNS addresses while the IP Addresses are necessary to form the Data Packets.
  To find the path, the Data Packets use the IP Addresses and not the DNS addresses.
  Consequently, it is necessary that somebody inform the Operating System of your machine which the IP Address of the targeted destination is when the DNS Address is known.
  The devices which store and perform the correspondence between the DNS Address and the IP Address are special Servers called DNS Servers.
  In order to take the information of equivalence offered by the DNS Servers between the DNS Addresses and the IP Addresses, your machine needs the IP Addresses of these DNS Servers. Usually, for reliability / fault Tolerance there are two DNS Servers which may be consulted; your machine receives two IP addresses from these two DNS Servers.
- The physical address of the NIC – the Network Interface Card - of your machine.
- The network mask, which indicates the bits of the given IP Address (of your machine) taken to the real address of the device (part of the bits of the given IP Address may not be taken into consideratio following the division into sub-networks). The bits which are not taken into consideration when forming the IP Address under consideration have the value 0 (logical zero). Also, the mask of the network indicates the type of network (A, B, C, D, E).
- Others.

The IPConfig tool displays the network settings of the respective machine inside the network environment.
Because the IPConfig works with the Internet environment, the machine must be connected to the Internet.
The IPConfig command is used to check the following: the settings of the machine (such as: the IP address of the machine, the address mask), the presence of the machine connection to the network and the settings of the network (such as: the IP address of the DNS servers which also serve the respective machine).

2.) Looking into and establishing IPConfig possibilities.

The MS-DOS indicates the options of the tool IPConfig.
To view these options it is necessary to:

- enter the MS-DOS program and change the directory, so that the MSD-DOS promptly indicate C:\>:
- give the following command:

C:\>**IPconfig /?** (Press Enter)

(It may also be written IPCONFIG, IPConfig etc).

The screen will display multiple possibilities and options of the IPConfig tool.

The resulting possibilities of the IPConfig/? command are presented in fig. 3.1.

The MS-DOS screen-shots may be viewed on the entire display by using the following command (simultaneously pressing) **Alt Enter**.
You may also return to the previous image on the display with the command **Alt Enter**.

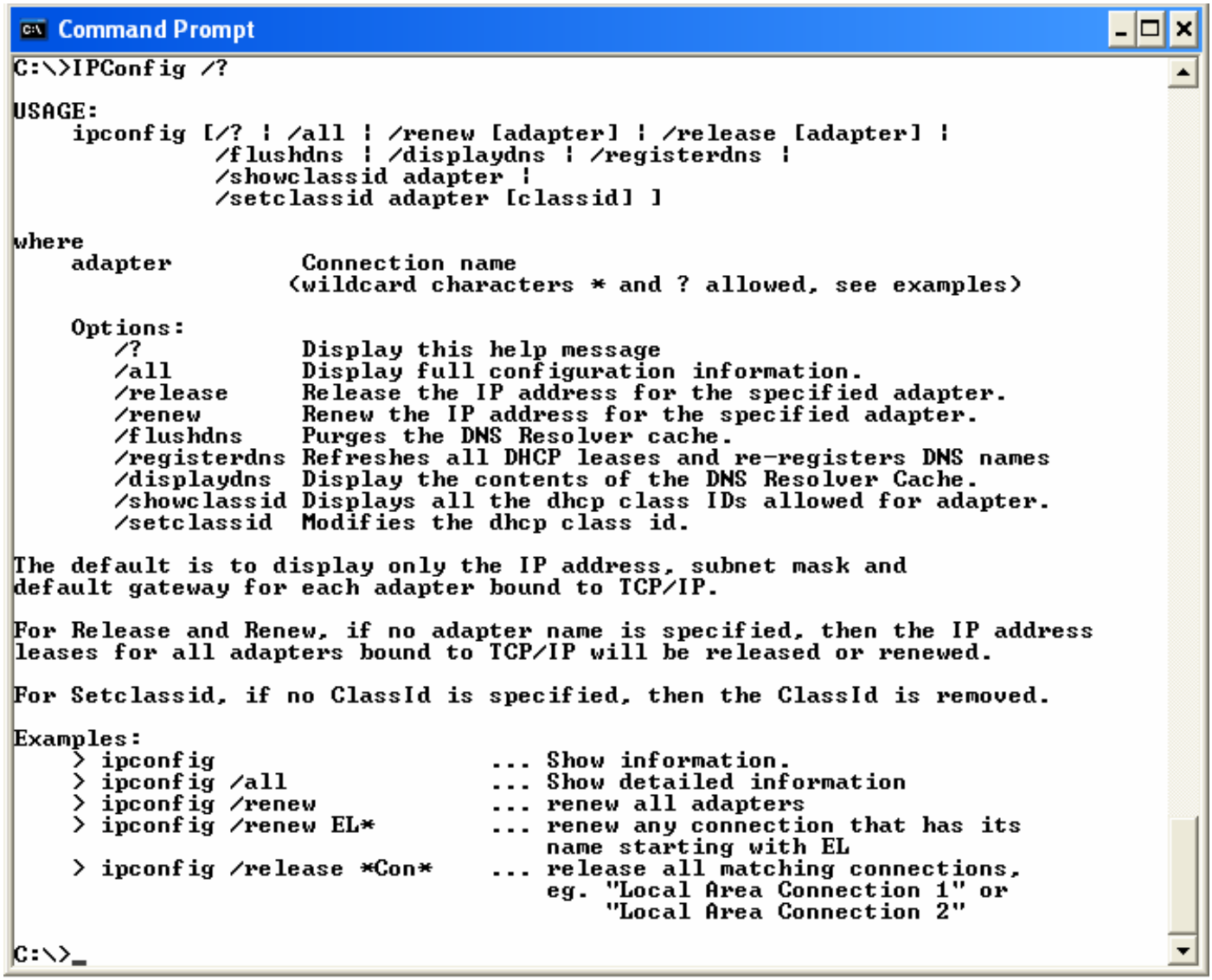

Fig. 2.1. Multiple possibilities of the IPConfig tool.

3.) IPConfig commands most frequently used.

Actually, for debugging, testing, troubleshooting a simple IPConfig command is frequently used, such as:

3.1.) C:\>**IPconfig** (Press Enter)

The Windows IP configuration will be displayed:

- The IP Address of the machine,
- The subnet mask and
- The IP Address of the Gateway (viewed from the network side).

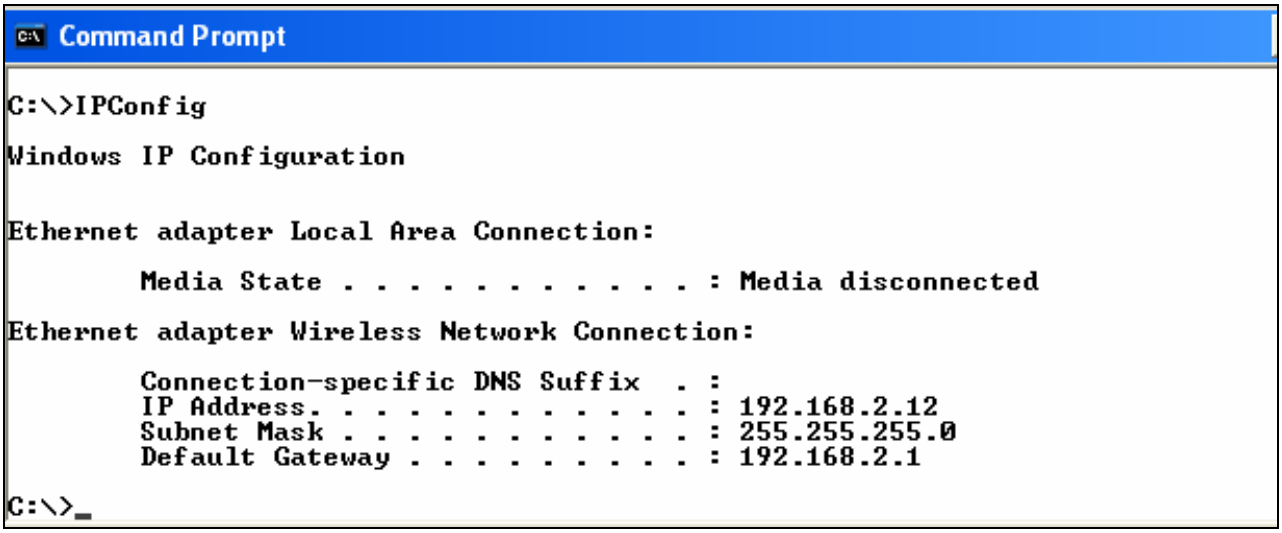

Fig. 3.2 The response to a simple command: **C:\>IPconfig** (Press Enter)

On debugging the new Internet partner and on troubleshooting, the above IPConfig command is often used to check the IP Address of its own device and the Default Gateway IP Address.

3.2.) A more complete IPConfig test is achieved with the command:

C:\>**IPconfig /All** (Press Enter)

This command delivers important Data about the machine and about the network in which the machine activates.

The results are illustrated in Fig. 3.4 in connection with the network configuration illustrated in Fig. 3.3.

The arrows show the connections between the essential elements provided after the command IPConfig and the network architecture presented in fig. 3.3..

The important elements indicated in fig. 3.3. and fig. 3.4.are:
- the IP address of your computer,
- the name of your own computer,
- the Physical Address (Address of the NIC - the Network Interface Card plugged to your own machine),
- the IP Address of the Default Gateway (viewed from the LAN side),
- the IP Addresses of the DNS Servers,
- others.

The information offered in fig 3.4. after **C:\>IPconfig /All** (Press Enter) command also includes the address of the DHCP Server, which is the Server working according to the Dynamic Host Configuration Protocol.
In this case, the DHCP Server is similar to the Default Gateway and has the same IP address.

The role of the DHCP Server (if the IP addressing of the machine is based on the DHCP procedure)
The IP addresses of the devices connected to the network may be established and set
- manually,
- automatically.

For the DHCP use, after an automatic negotiation between the machines (your machine and the machine of the DHCP Server) the DHCP establishes for a while, in a dynamic mode, the IP addresses of each network partners which use the DHCP.

Fig. 2.3.

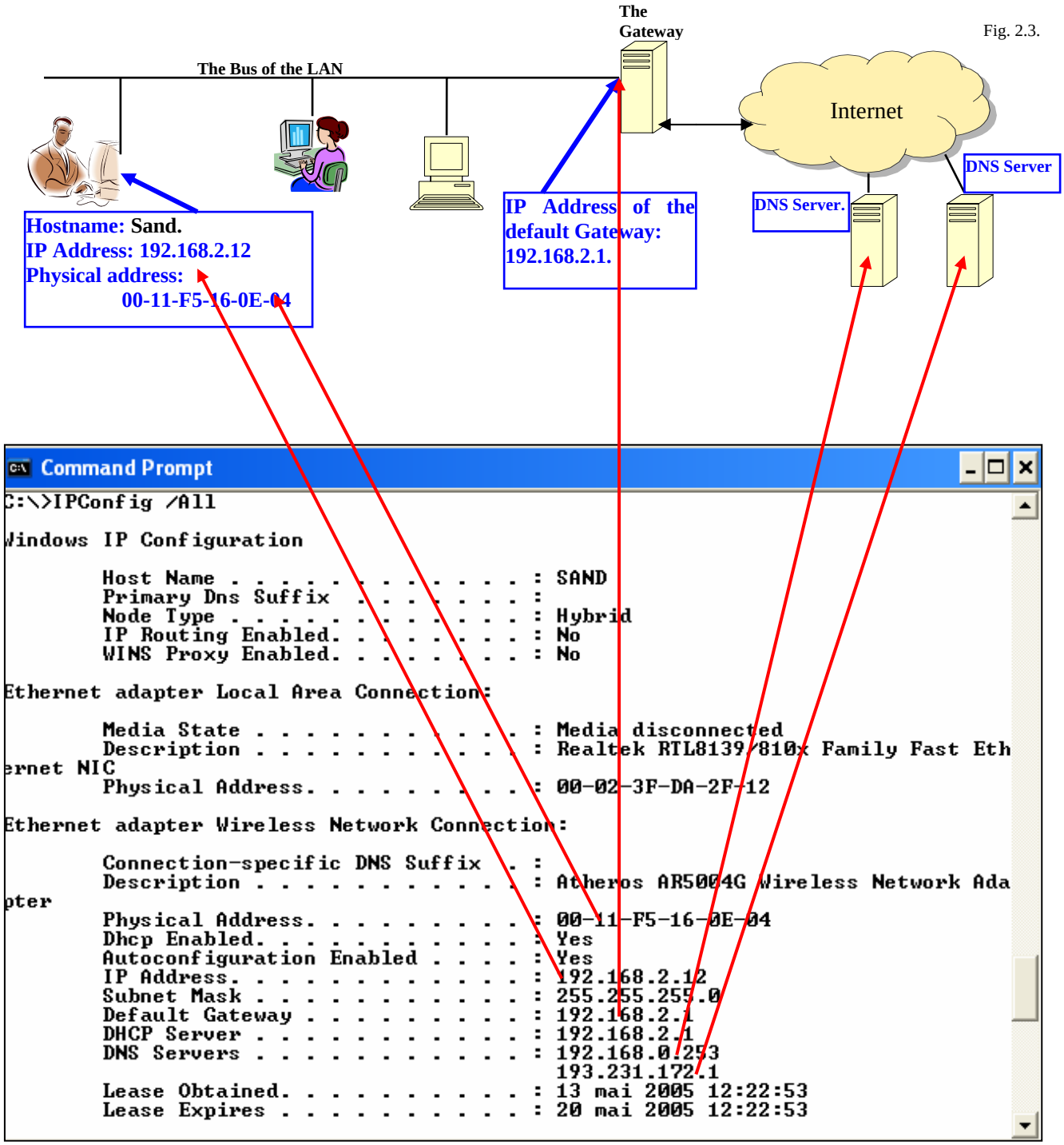

Fig. 3.4. The response at the **C:\>IPconfig /All** (Press Enter)

4. TRACERT: YOUR PRACTICAL EXPERIMENTS IN MS-WINDOWS.

The animation on the CD indicates how to reach the MS-DOS and how to practically use Tracert diagnosis tool.
You are ready to start the experiment.
You will launch the TRACERT Internet tool to the targeted IP Address or DNS Address or Hostname.
Most frequently, TRACERT is launched in MS-DOS with the command

C:\>**TRACERT [the IP Address or the DNS Address]** (Press Enter), for instance
C:\>**Tracert 192.4.56.3**

(the command will be written without brackets).

The TRACERT command possibilities.

The possibilities of the TRACERT command are accomplished with the following:

C:\>**TRACERT /?** (Press Enter)

Describing the functioning of the TRACERT diagnosis Tool

The animation on the CD describes how the data packets travel and collect the information from the network diagnosis.

The Tracert diagnosis tool functions based on the Test-Data packets which are launched to the Internet network. The header of the Data-Test Packet carries the IP Destination Address, the Sender Address and other information.

The Data Packet sequentially arrives in each Hop.
Now and then, each Hop which keeps the Test-Data Package stationed returns a feedback Data Packet to the first/initial sender of the Tracer Test-Data Packet, as well as to your machine.
The feedback includes information about the Tracert diagnosis results.
The results are displayed in sequences on your screen, line after line.

Tracert may achieve multiple connectivity tests between Hops. In this case, Tracert automatically launches the testing of the time necessary for a transfer of Data Packet between two selected successive Hops.
That means that between two Hops, Tracert launches an exchange of multiple Test-Data Packets.

When the packet is sent from Router to Router, the specific IP Address of each intermediary destination (Router) is automatically included in the header of the Data Packet, without losing the final information about the targeted IP Address (the IP Address of Destination).

Dealing with unclear issues
Directing the TRACERT diagnosis tools to the DNS addresses. The hidden functioning of the Tracert diagnosis tool.

More.
ⓘ As you have seen in your first experiment, the Data Packets are sent to the DNS address.
But the DNS address is never used as a destination address in the header of the Data Packet..
Only the IP Address of the destination is always used in the header of the Data Packet.

How can your machine know the IP Address when you have sent only the DNS Address?

To solve this important issue, the DNS server is used.
The DNS Servers (Domain Name System Servers) are servers placed anywhere in the world and contain Correspondence tables between the DNS addresses and IP addresses.

When applying the TRACERT diagnosis tool to the DNS addresses, the Source device (your machine) sends a questioning Data Packet to the DNSs servers before forming the Test-Data Packet.

The reason for this sending is to find the IP Address when the DNS address is known.

After displaying the IP Address, the Tracert procedure and diagnosis tool start testing the path, Hop by Hop, to the targeted IP Address.
These initialization packets are sent to the destination IP address.

* * *

ⓘ The MS-DOS tool TRACERT or tracert (or the Linux tool TRACEROUTE or Traceroute) represents a powerful diagnosis tool.

Starting the TRACERT tool in your experiment:
You will launch the test tool Tracert using the command:

C:\>Tracert www.altavista.com

This means that you have launched the Internet testing tool that Tracert targeted to the DNS address of the well-know search engine ‘Altavista’, namely www.altavista.com.

After giving the above command, the screen will display the following image (white writing against black background on your screen. In the example below, the results of the experiments are presented in black writing against white background).

By pressing ALT + ENTER (both keys simultaneously) your screen will show the MS-DOS image.

By pressing CTRL + C (both keys simultaneously), you stop the test.

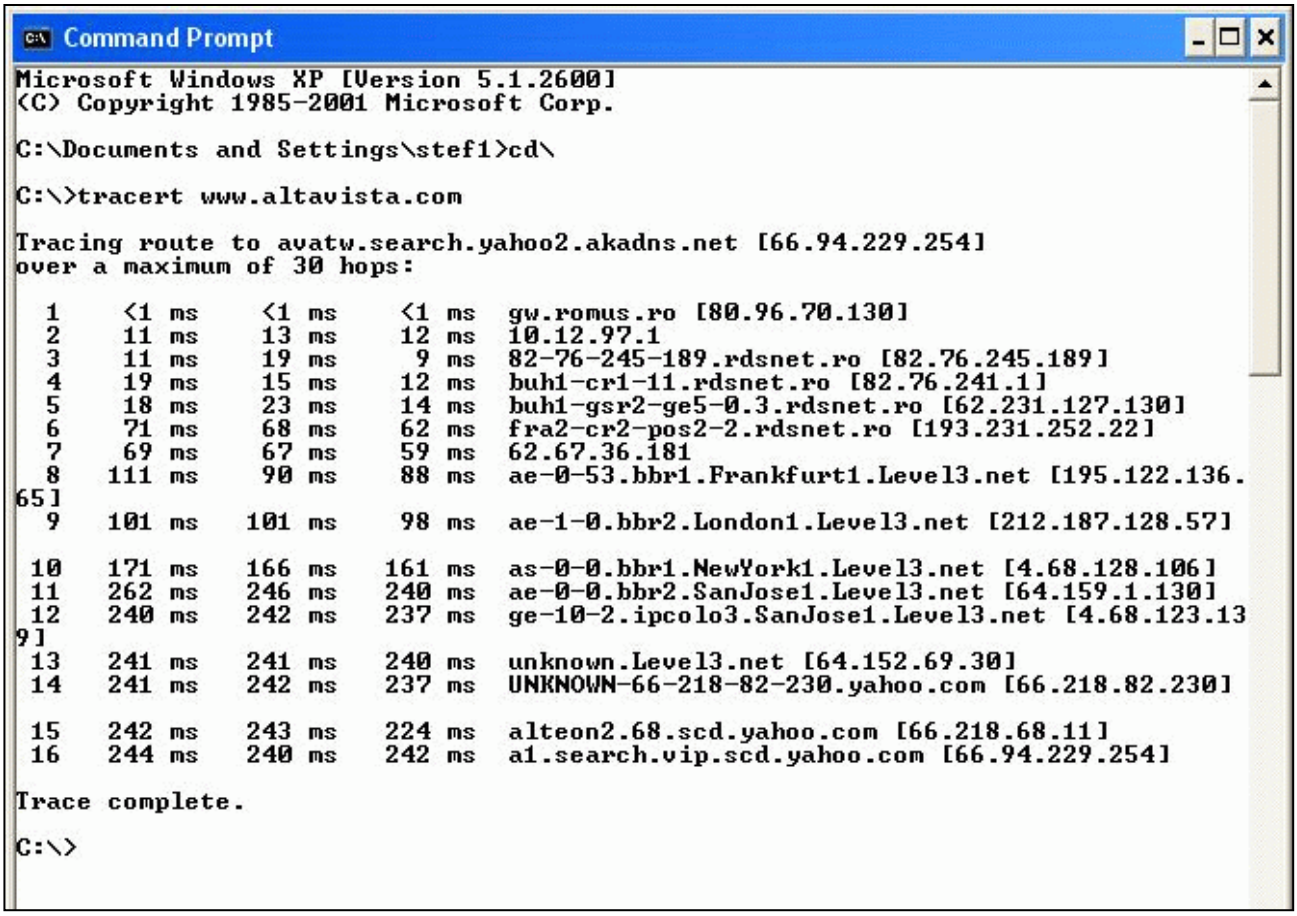

Fig. 4.1 Experimenting the Tracert diagnosis tool to a DNS address.

The test automatically advances step-by-step, offering a new location of the Data Packet at each step, illustrated by a new line of information on screen. Each line corresponds to the Server or device which the Data packet travels through.

It takes a few fractions of a second for each new line to show.
This important test ends in fractions of a second or seconds.

Fig. 4.2 illustrates the way in which the packets have travelled according to fig. 2.1

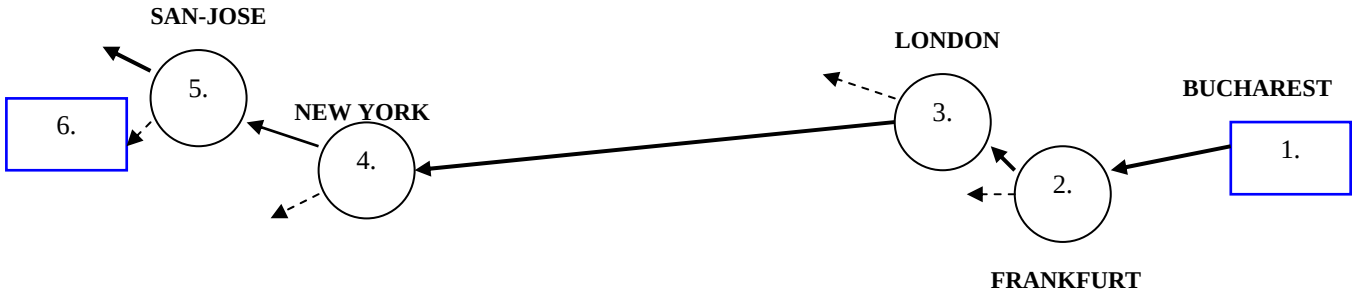

Fig. 4.2 The travel itinerary of the Tracert Data Packets presented in connection with the results illustrated in fig. 4.1 and fig. 4.3.

What did the testing tool do?
After launching the test, the Operating System of your PC or Laptop has done some preparatory actions (in a few tens of milliseconds) in which the TCP/IP protocol prepares the Data Packet for sending.
In the case above, the screen indicates the IP Address **66.94.229.254,** which at the time corresponds to the DNS address **www.altavista.com**.

You may see in the above screenshot (on line 5) that the testing tool Tracert has displayed the IP Address **66.94.229.254** corresponding to the DNS Address **www.altavista.com**.

The Operating system of your machine prepares a Test Data Packet, places the IP Destination address **66.94.229.254** in the Header of this Packet, and sends this packet to the Destination IP Address.

After the Data Packet is prepared, it is sent to the network targeting the Destination IP Address **66.94.229.254** (which corresponds to the DNS address **www.altavista.com**)

To perform the diagnosis test, the packet is first sent according to **Trace 1** to the IP Address of the Gateway of the LAN-Local Area Network. Your machine is locally included in this network.
This local network communicates with the Internet through a Gateway. The input IP Address of this Gateway (viewed from your LAN side, fig. 3.4, is indicated on Trace 1: 80.96.70.130).
Because the targeted IP Address is not an IP Address from their own LAN, the Data Packet must be sent through the Gateway to the Internet. More…

ⓘ What indicates the Gateway IP Address to the operating system?

The operating system knows the IP Address of the Gateway and of the path between the Local network and the Internet, because this address is set in your machine during the Internet configuration stage of your machine.
When your machine is configured for the Internet, you receive an IP Address of the Gateway. This Gateway IP Address is usually set from the keyboard of your computer.
This Gateway address may be seen and known immediately through another important and simple Internet tool: the IPConfig, that you have practiced above.

2. The data packet is sent from the Gateway, **Trace 2,** and arrives at the Hop with the IP Address: **10.12.97.1,** which is the IP Address of the intermediary device to the destination.

3. The Test Data Packet is sent, **Trace 3**, and arrives at a device of the RDS NET (ISP-Internet Service Provider) Servers with the IP Address: **82.76.245.189,** as it is indicated on screen by the Tracert testing tool.

4. The Data Packet is transferred between the servers of the RDS NET. The Data Packet arrives, **Trace 4**, at the machine with the IP Address: 82.76.245.1, and from there it is transferred, **Trace 5**, to the RDS NET machine (or Gateway) in Bucharest, with the IP Address: 62.231.127.130.
From the device with the IP Address 62.231.127.130, the Data Packet is sent – **Trace 6 –** to the device with the IP Address 193.231.252.22 and it is transferred – **Trace 7** – from this address to the device with the IP Address 62.67.36.181, possibly the RDS NET Gateway to the Internet backbone.

5. After some fractions of a second, your screen will display **Trace 8,** indicating that the data Packet has arrived at the Router with the IP Address 195.122.136.65 in Frankfurt. The time taken by the packet to transfer from Bucharest to Frankfurt is indicated on screen: about 100 milliseconds.

6. In **Trace 9**, the Data Packet is transferred from the Server in Frankfurt to a Server in London with the IP Address: 212.187.128.57. The average time for transferring the Data Packet from Frankfurt to London is of about 100 milliseconds.

7. From London, the Data Packet is sent to New York – **Trace 10 –** to the IP Address 4.68.128.106. The transfer of the Data Packet from London to New York is achieved in about 160 milliseconds.

8. From New York, you may follow the transfer of the Test Data Packets to the servers in San Jose.

☺ After passing through other indicated routers and servers, the Data Packet arrives at the final destination, the machine with the IP Address
66.94.229.254.

Through this practical experiment, you could see a practical example of a real-time transfer of Data Packets from Hop (Router or server) to Hop (Router or server).

You may also exercise the Tracert diagnosis tool targeted to the IP Addresses:
C:\>Tracert 66.94.229.254 (Taste Enter)

The launched diagnosis tool Tracert will gradually offer the transfer of the Data Package from router to router, from Bucharest up to San Jose California, USA, and the feedback reaching each server will be displayed on screen, line after line.

The step-by-step picture of this experiment is presented below:

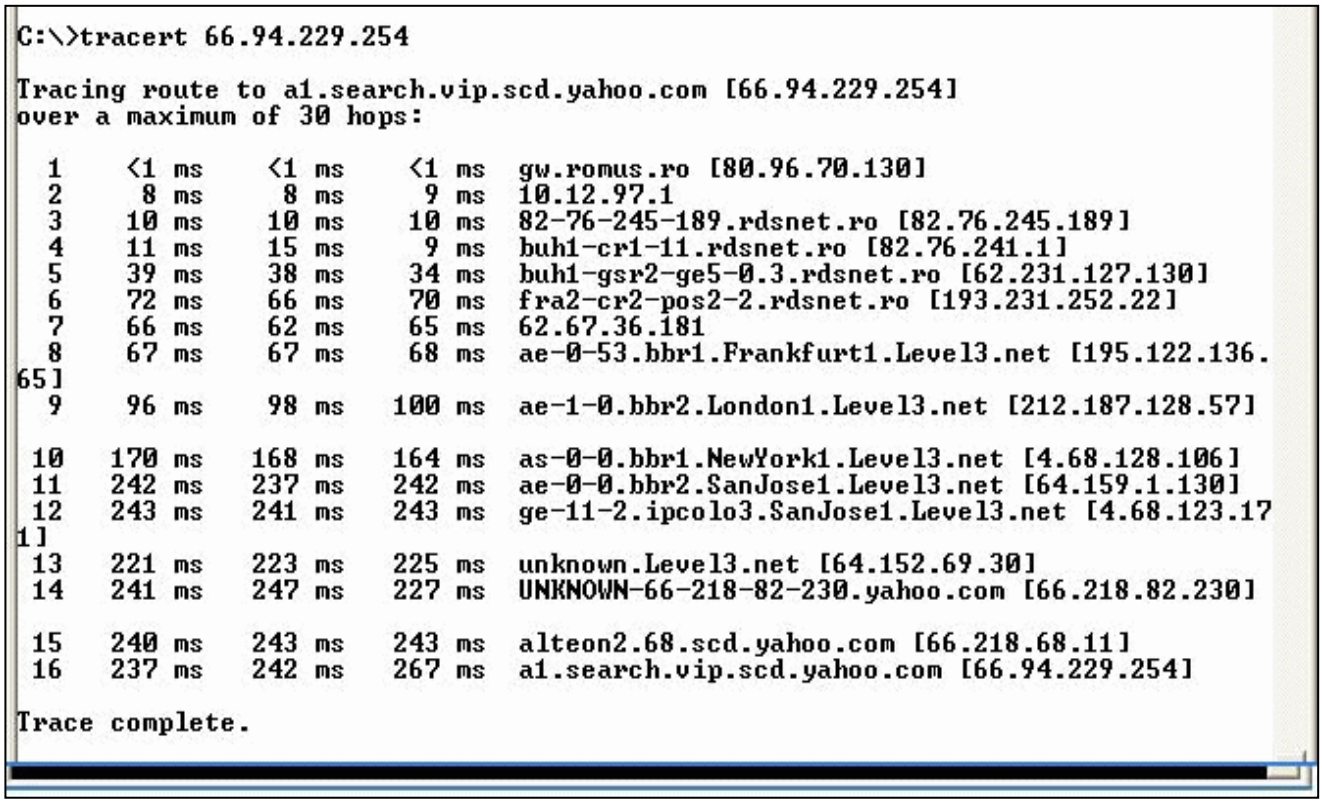

Fig. 4.3 Experimenting the Tracert diagnosis tool to an IP address.

In this case, the intercontinental path and travel of the Data Packet Hop by Hop is accomplished along the same way, namely through the same Hops (Routers, Servers) as in the first experiment.

Figures 4.1.and 4.3 reveal for the present tests that the Data packets have used (helped by the Routers' decisions) the same way of hops.

As you see in fig. 4.3, the tests are performed three times for each point where the Packets arrive.
Each traveling time to a hop placed on the path is measured from the moment it leaves the initial source (your machine).

The Data Packet need not use the same path many times.
The Data Packet may select and may be directed through the other chains of Hops, depending on the setting mode of the Routers and the state of the network (congestion, faults etc).

More practice is presented in the following movie. Please click on the following quadrant to see the movie.

The complete live presentation of the Tracert process is illustrated on the CD.

5. ADVANTAGES OF THE TRACERT DIAGNOSIS TOOL.

Through the above practical experiment, you could actually watch and follow the travel of the Data Packet from Hop to Hop, i.e. from one Router (or Server) to another Router (or Server) in real time.

It is important to emphasize that:

- 31 The Tracert test ensures measurement of the Data Packet transfer time when travelling between one Hop to the next Hop.
  You have seen that the transfer time (between Europe and America) is of about 100 -200 milliseconds.
  The following situations are also possible:

- If the transfer time, between two Hops is long (for instance, of over 500 milliseconds), it may then be concluded that there are problems, disturbances on that specific network section.
- If the transfer time between two Hops is longer than 400 milliseconds, for instance, there is an indication about a strong congestion (very intense traffic) on that respective network portion.

- If, during the transfer between two Hops, the Tracert tool indicates: **Request Time Out**, then either the transferring process has incurred a break (due to network congestion) or the transfer is broken and the passing of the Data Packet to the destination is failing.

- 5. The Tracert test allows detecting the status: the good functioning or failure of a path of Data Packets. Tracert identifies where the malfunction lies, between which servers or routers the connection is broken, or in which zone the routers are out of operation.

If during a travel between two Hops the feedback response does not come in time as set before, this indicates that communication is broken (finally or temporarily) at the respective hop (Router).
Troubles or failures, especially broken connections or speed decrease, may be quickly identified using this method.

- 6. The Tracert tool functions for controlling the functioning path:
  - from your PC or laptop to a machine placed in a different part of the world or
  - even inside your machine. Inside your machine, you may launch the Tracert tool to the internal IP address contained in all machines: 127.0.0.1. Using this internal IP address allows launching the Tracert as:

C:\>Tracert 127.0.0.1

The good response to this test certifies the good configuration of the TCP/IP protocol on your machine.
In a positive case, the Tracert response to the internal machine test is: **Trace complete**
and the transfer time is of under 1 millisecond.
There are also other tests that confirm the good configuration of the TCP/IP protocol in your machine.

- 7. The Data packet travels through each hop (Routers) of the path to the destination address. From each hop that has been reached, the TRACERT procedure and diagnosis tool sends feedback to the source, including the time of travel between the latest hops.
  Simultaneously other information is indicated, such as the IP Addresses of the Servers (Routers) that the Data Packet go through.

- 8. If problems are detected, the tool indicates directly where the interruption is located. Unlike PING diagnosis tool, TRACERT does not require a step-by-step procedure.

- 9. The TRACERT diagnosis tool and the PING (another Internet diagnosis tool) get activated in the same way, but the former offers more complete and direct information about the path.

- 10. The Data Packet remains inside the Hop for a while. Because the Hop serves the Data Packets based on the principle: first input→first output, the arrived Data packets do not have to wait for the Data Packages which arrived before but are processed and sent to the required destinations.

<u>Other advantages offered by the Tracert diagnosis tool.</u>
From the place of the ISP or from the place of each work station (laptop, PC) the Tracert diagnosis tool has the following applications:

- following step by step (hop-by-hop) the advancement of the Test-Data Packet to the Destination by passing through various devices
- offering information about the speed of the Data Packets, i.e. the Throughput (see chapter 7) of the network at that specific time,
- indicating the zone (the hop) where the transfer is interrupted,
- indicating the IP address and other Data about the Servers (Routers) through which the Data Packet travels toward the Destination
- the possibility to detect the functioning mode of each device of the networking path.
- checking and detecting the connectivity.

The diagnosis tool Tracert also provides:

- the possibility to use extremely simple commands,
- the possibility to use commands to the IP Addresses, the DNS addresses or the Host names.
- to find the IP Address when the TRACERT is directed to the DNS addresses,
- to detect the troubles associated with DNS addresses, DNS Servers, and other

Scenario.
In one case, the Tracert diagnosis test correctly operates to the IP Address, but does not function when the Tracert targets the DNS addresses. The trouble lies in the DNS addresses: incorrect addressing, incorrect IP address of the DNS routers etc.

- The machine works with the TRACERT diagnosis tool, with the possibilities to reach internal points within the machine or remote Internet locations around the world.

6. HOSTNAME AND OTHER DIAGNOSIS TOOLS.

1.) The Hostname.
The Hostname is a simple MS-DOS command which allows the machine name to be known.
This is launched with the following command:

C:\>Hostname (Press Enter)

and your machine responds, for instance:

C:\>Maria

Some other important diagnosis tools are presented in the following lessons related to the Internet diagnosis and troubleshooting.

7. MEASUREMENT UNITS. PRINCIPAL CHARACTERISTICS OF THE NETWORKS: BANDWITH AND THROUGHPUT. BASIC UNITS OF DIGITAL COMMUNICATIONS

1.) Units of information:
The essential information units are the following:

- Bit (b) Binary digit, 1 or 0.
- Byte (B) 1 byte includes 8 bits.
- Kilobyte (KB). 1 KB includes 1024 bytes.
- Megabyte (MB). 1 MB includes 1024 Kilobytes, that is 1,048,576 bytes.
- Gigabyte (GB) 1 GB includes 1024 Megabytes, that is 1,073,741,824 bytes

2.) Units of data rate and Units of Bandwidth .

Most networks consist of serial connections between computers.
Working with this serialized Data, the transmission speed of the bits of the train of impulses is an essential characteristic of the networks.

3.) Bandwidth definition:
The Bandwidth represents the network ability to provide an indicated data speed.

Practically, the Bandwidth represents the maximum number of bits which can pass through that network.
The value of the Bandwidth is finite. The value of the Bandwidth influences the levels of expenses and is the first performance which characterizes the network.

The world constantly tries to increase the Bandwidth and find procedures and advanced technologies for a better use of the Bandwidth.

4.) The Throughput definition:
The Throughput represents the real Bandwidth at a specified time.

Under various influences (network congestion, unreliability, noise etc), the value of Throughput diminishes compared with the Bandwidth.

The Network congestion represents a decrease of the network speed when the number of the Data Packages to be transferred is larger than what the network can sustain.

The level / value of the Throughput is influenced by:

- The Server functioning conditions and the Server speed,
- The topology / architecture of the respective network,

- Types of Data,
- The level of transmission congestion (often related to the time of the day), the type of activities and the number of other partners of the respective network; the Routers availability, the availability of the high hierarchy networks connected to the Internet,
- The levels of electromagnetic perturbations and transmission errors.

Bandwidth and Throughput Measure.

The speed of the serialized data rate is measured in:

- Kbps Kilobits per seconds , that is, x1,000 bits per second
  1Kbps = 1,000 bps
- Mbps Megabits per seconds , that is, x 1,000,000 bits per second,
  1Mbps = 1,000,000 bps
- Gbps Gigabits per seconds , that is, X 1,000,000,000 bits per second.
  1Gbps = 1,000,000,000 bps.

If the data is in Bps, i.e. bytes per second, where one byte consists of a train of 8 bits, the correspondent relation between the Kbps and Bps is given by the relation: 1Kbps = 125 Bps.

5.) **The Transfer Time Calculation (TTC) according to the BW Bandwidth**.

The TTC represents the time necessary to transfer the Data Packet through a network (including the time consumed in processing the Data inside the Hops) and is determined by the data Packet length and bandwidth and the length of the file.

A. In an ideal scenario with an optimum download, the TTC – Transfer Time Calculation :

$$\mathbf{TTC}\ [\text{in seconds}] = \frac{\mathbf{S}}{\mathbf{BW}}$$

Where:
S is the file size under the form of serialized bits (the length).
BW [in bits per second] is the maximum theoretical bandwidth of the slowest channel / link between the source (for instance, the host) and the destination (for instance, the workstation).

B. Under normal circumstances:

$$\mathbf{TTC}\ [\text{in seconds}] = \frac{\mathbf{S}}{\mathbf{P}} \times \mathbf{k}$$

Where P [in bits / second] is the Throughput at the moment of transfer.
k < 1 is the coefficient of diminishing the TTC, under negative influences.

6.) Examples of the bandwidth and throughput for some networks.

Table 1. Examples of bandwidth and throughput for some networks and Data transfer connections.

Type of WAN Service	**Bandwidth**	**Estimation of the possible Bandwidth reduction (only gross estimation)**
Dial-up Modem	Max. 56 Kbps	Reduced with about 50%
ISDN	128 Kbps	Reduced with about 50%
T1	1.5 Mbps	Reduced with about 50%
T3	44.7 Mbps "A T-3 line actually consists of 672 individual channels each of which supports 64 Kbps"	Reduced with about 50%

	http://www.webopedia.com/TERM/T/T_3_carrier.html	
E1	2 Mbps (2.048 Mbps) http://www.icp-nis.co.yu/Srpski/faq/CableModem/CableModem.html	Reduced with about 50%
E3	34 Mbps E3 (34.368 Mbps) http://www.icp-nis.co.yu/Srpski/faq/CableModem/CableModem.html	Reduced with about 50%
Data Comm backbones	2.48 Gbps and more	Reduced with about 50%

Key Points. Summary. Conclusions and Recommendations

Tracert, IPConfig and Ping are powerful Internet diagnosis tools, often used in the troubleshooting activities undertaken by Internet technicians, engineers and not only.
These tools prove the way the Internet functions and important aspects of the TCP/IP protocol including:
- the Data Packet-oriented transfer,
- connection-less procedures,
- the separation principle for each entity involved in the Internet,
- the game of the IP Addresses, Physical addresses and DNS addresses,
- efficient diagnosis tools.

Study Guide

ESSENTIAL QUESTIONS TO EVALUATE THE ACQUIRED KNOWLEDGE

1. For the following DNS address www.oracle.com which is the IP address?
2. How can we know the options of the Tracert diagnosis tool? How is launched the Tracert diagnosis tool to the DNS address www.altavista.com , including the options: a non-implicit timeout of 500 ms, a maximum number of ten hops, a loose source route along the host-list?
3. Why does the diagnosis tool Tracert to the DNS address function when the IP address is unknown?
4. What does the TCP/IP signify and what is the TCP/IP?
5. How can your machine know the address of the DNSs servers?
6. What is the Bandwidth?
7. What is the Throughput?
8. Why does the Throughput diminish in real systems compared to the bandwidth?
9. Which information does the diagnosis tool Tracert offer?
10. Which distances may be taken into consideration when applying the Tracert diagnosis tool? Which is your machine internal address for the local test with Tracert? Which is the contribution of this local test?

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SUPPLEMENTARY GUIDANCE ON THE CONTENTS OF THE LESSON

It is recommendable to undertake more practical exercises of this type: Tracert to DNS and to IP addresses, Ping toward DNS and to IP addresses and IPConfig and to then evaluate the results, including the RTT- Round Trip Time.

ANSWERS TO QUESTIONS

1. To accomplish the IP address of the indicated DNS address, it is necessary to launch the Tracert diagnosis tool to the respective DNS address.
2. C:\>**Tracert /?** (Taste Enter). C:\>**Tracert -w 500 –h 10 –j www.alatavista.com** (Taste Enter).
3. By accomplishing the IP Address, when the DNS is known by the TCP/IP protocol and operation: Address Resolution. Thorugh this operation, your machine automatically requires the IP Address correspondent with the indicated DNS Address from the Data bases from the DNSs servers.
4. The TCP/IP represents a suite of protocols Transmission Communication Protocols/ Internet Protocol that the Internet relies on.
5. The addresses of the DNSs servers is introduced into your machine with the keyboard when configuring the Internet connection of your PC or Laptop.
6. The Bandwidth represents the maximum speed which may be accomplished with the network under ideal circumstances.
7. The Throughput represents the real speed, lower than the Bandwidth, at a specified time.
8. Because the Data Packets must be resent following the noise and other perturbations, because the digital conversation between computers is not continuous, because the data are sent in time sharing / time windows, as well as other causes.
9. The Tracert diagnosis tool offers the following essential information: A. connectivity information: continuity of the path; B. The portion of the path where an interruption is located; C. The transfer time of the Packet is between two Hops.

10. The Tracert is not influenced by distances. It works inside your local PC (**C:\>Tracert 127.0.0.1)** or in any place in the world. The locals test (**C:\>Tracert 127.0.0.1)** offers primary information about the good installation of the TCP/IP protocols on your machine.

WORDS TO THE LEARNER: ***"Do not wait for opportunities. Create them."*** (After Bernard Shaw).