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ZHAMANOV AZAMAT

MICROLEARNING IN COMPUTER NETWORKS

6M070400 - Computer Software and Hardware

Dissertation of Master of Science degree

Almaty – 2012

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SULEYMAN DEMIREL UNIVERSITY

«Allowed to defend the thesis»:
Head of Computer Software and Hardware department

Dr. Ivanov A.I _____

«___»_____ 20___y.

Head of Postgraduate education department

PhD. Shalbayev A.A. _____

«___»_____ 20___y.

DESSERTATION OF MASTER OF SCIENCE DEGREE

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Specialty: 6M070400 - Computer Software and Hardware

Graduate Zhamanov A.M.

Adviser Dr. Ivanov A.I.

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GLOSSARY

Bandwidth - the rated throughput capacity of a given network media or protocol. The amount of data that can be transmitted in a fixed amount of time.
Backbone - A high-speed link joining together several networks.
Bit – A unit of information having just two possible values, as either of the binary digits 0 or 1.
Byte - a series of consecutive binary digits that are operated upon as a unit. There are 8 bits in a byte.
Category 5 (cat 5) cable -A type of twisted pair network wiring in which there is a certain number of twists per foot. It is the most commonly used network cabling.
Coaxial Cable - A type of cable consisting of two insulating layers and two conductors most commonly used in older networks.
Collision - An attempt by two devices to transmit over the network at the same time usually resulting in the data being lost.
DNS (Domain Name System) - an internet service that translates domain names into IP addresses. For example www.google.com translates to 66.102.7.99.
Dynamic DNS - A method of keeping a domain name linked to a changing IP address using a pool of available IP addresses so you can use applications that require a static IP address.
Domain - A group of computers and devices on a network that are administered as a unit.
DHCP (Dynamic Host Configuration Protocol) - A TCP/IP protocol that dynamically assigns an IP address to a computer. Dynamic addressing simplifies network administration because the software keeps track of IP addresses rather than requiring a network administrator to do so.
Ethernet - Ethernet is the most widely installed local area network technology. It was developed during the late 1970s through a partnership of DEC, Intel, and Xerox.
Fiber Optic - A cable technology that uses glass (or plastic) threads (fibers) to transmit data. It is a very fast technology
Gateway - A device on a network that serves as an entrance to another network and routes traffic
Hardware (MAC) address - A unique address associated with a particular network device
Hub - A common connection point for computers and devices in a network that takes an incoming signal and repeats it on all other ports
Internet - Term used to refer to the world's largest internetwork, connecting thousands of networks worldwide. Also known as the world wide web (www)
IP address - a 32-bit address assigned to hosts using the TCP/IP protocol. Each computer/device on the public internet has a unique IP address. An example of an IP address is 192.168.1.
LAN (Local Area Network) – computer/data network which is confined in a limited geographical area.
MAC Address (Media Access Control) - A unique identifier attached to most forms of networking equipment. It is burned into the device and cannot be changed

Megabit - A measure of data transmission speed - 1 million bits per second or approximately 125,000 characters per second
Megabyte - A unit of measure for memory or hard disk storage capacity. 1024 megabytes = 1 gigabyte.
Network - A group of computers and devices that can communicate with each other and share resources.
Network Interface Card (NIC) - A hardware device inside a computer or other network device that enables communication with a network.
Packet - The unit of data sent across a network. Data is broken up into packets for sending over a packet switching network.
PING (Packet Internet Groper) - A command used to test connectivity to a device over a TCP/IP network.
Protocol - Rules determining the format and transmission of data over a network
RJ-45 - Standard connectors used for unshielded twisted-pair cable. Most commonly used with Cat5 network cabling.
Route - A path through an internetwork.
Router - A device that routes/forwards data across a networks.
Server - A computer that handles requests for data, email, files, and other network services from other computers (clients)
Subnet - A portion of a network that shares a common address component but is on a different segment than the rest of the network.
TI Line - A high speed dedicated data line that supports a transmission rate of 1.544 Mbps
TCP/IP - Transmission Control Protocol/Internet Protocol. A suite of protocols used as the basis of the nation's internetwork (Internet). It can also be used on internal networks.
UNC (Universal Naming Convention) Path - A UNC provides a naming convention for identifying network resources. UNC names consist of three parts, a server name, a share name, and an optional file path.
WAN (wide area network) - A network linking together networks located in other geographic areas.

LIST OF ABBREVIATIONS

ACK – Acknowledgment

TCP – Transmission Control Protocol

UDP – User Datagram Protocol

DNS – Domain Name Service

TBL – Technology based learning

CBT – Computer based training

IBT – Internet based training

M-learning – Mobile learning

DHCP – Dynamic Host Configuration Protocol

ML – Microlearning

INTRODUCTION

In nowadays we have much kind of problems in the system of higher education. Actually there are a lot of reasons. But in this thesis I will explain only one reason. Only one but in my opinion it is one of the main reasons.

Students especially in our university everyday get very huge amount of information. Every student can take up to 8-9 courses in one semester. During one day student will have to go to 5 - 6 lessons. From every lesson he will have to read at least one chapter. It will take about 1 - 2 hour to read chapter and to understand it. So you can see that it will take very big amount of time for a student to understand all lessons and it will be very hard for him/her to do everything in time. But this is only one side of a coin.

According to a Soviet Union system of education. Student has to read very much if he wants to learn some topic. He reads a lot of information about the things that are concerned with his topic. This is a good practice but unfortunately not now. Because now it is information age. Information is increased every day. And it is not possible to know everything. Especially this is true for information technologies sphere where new technologies are developed every day. The thing that you learned yesterday may be not needed tomorrow because it will be old and new technologies will come and you will have to relearn again.

So what can we do in this situation? We can use the microlearning method which is very popular now in the world. The main principle of this method is to divide one huge complex information into many small pieces and try to make them as easy as possible. Leave only main parts, only necessary things and try to give more good examples. This makes work very easy. You can learn a small part of information in 15 minutes and then practice it. And in this way you learn step by step until you will learn everything at all. Now when you know enough about this topic you can deal with complex things related to your topic. Because you are aware of what it is about. You have so called fundament.

Let me show an example. Say you want to learn what Computer Networks is. We have many books that explain you what is this Science about. But most of these books are very huge and sometimes boring books. Instead many people are making search request in Google and find good tutorials for them. For example w3schools.com. Why? Because it will take about 20-30 minutes for you to understand the main principle of Computer Networks without going into details. If you want to learn more about this topic, I mean if you want to learn some specific or more detailed information about it, then you can read a book. And because it has exhaustive examples that can teach you a lot. Also it is very good to memorize this topic. Now I will try to explain my idea more clearly.

Purpose of the study

The purpose of this study is to investigate how and why microlearning approaches especially microlearning based on mobile technology can help in our current system of education. How can it solve nowadays student's problems related with understanding complex information, especially for those whose language of instruction is English? I say this because the technical vocabulary of most students is not enough to learn complex information. I will try to show best international practices that took place in different countries and universities. And in the end I will demonstrate my book which was developed for students of our university to easily learn Computer Networks course.

Significance and topicality of the study

The traditional system of education where students listen lecture during 2 hours and read tens of pages in order to understand the lecture shows that it is not efficient. Not many students can accept so much information. Not many students can accept complex information, especially if this information is in foreign language, as it is in our university. As a result students do not gain knowledge on a sufficient level.

There must be a way that can overcome this problem. A way that can suggest a solution in our new era. Ways that will offer an opportunity to go with the times as new technologies arise. It must give possibility to a student to learn very easy without going into deep and to learn everywhere. It also must give an opportunity to find quickly an answer to your current question.

The things like microlearning, mobile learning and e-learning and others are the solutions to these problems. It doesn't mean that a traditional method should be replaced with these new methods at all. Rather it should be integrated into traditional system. The traditional lectures should be divided into some microlectures, microcontent and so on. And student must have a possibility to study independently everything by himself/herself using informat that is based on microlectures.

Aim

My aim is to develop such a book that will give possibility for students to learn material easily and quickly. I want to start this idea on Computer Networks lectures. Because I have enough experience on this course to be able to analyze what kind of obstacles do students can have while investigating it. I want my book to be available for most students.

In my application I will try to take into account following important things:

- **Time:** relatively short effort, operating expense, degree of time consumption
- **Content:** small or very small units, narrow topics.
- Curriculum: small part of curricular setting, parts of modules, elements of informal learning.
- **Learning type:** repetitive, activist, reflective, constructivist

Novelty of the work

The method on which my work is based is relatively new method in the world. In Kazakhstan we don't have such methods in none of the universities. I investigated this in internet and I haven't found any information. Even more if you will try to search about this topic in internet you will not find much information except some certain resources. As I explained above, this is mostly because our system (traditional) is still based on old system of education.

1 TECHNOLOGIES AND METHODS

1 Microlearning deals with relatively small learning units and short-term learning activities. Generally, the term "microlearning" refers to micro-perspectives in the context of learning, education and training. More frequently, the term is used in the domain of e-learning and related fields in the sense of a new paradigmatic perspective on learning processes in mediated environments on micro levels.

1.1 Introduction

In a wide sense, microlearning can be understood as a metaphor which refers to micro aspects of a variety of learning models, concepts and processes.

"No matter if learning refers to the process of building up and organizing knowledge, to the change of behaviour, of attitudes, of values, of mental abilities, of cognitivestructures, of emotional reactions, of action patterns or of societal dimensions, in all cases we have the possibility to consider micro, meso and macro aspects of the various views on more or less persisting changes and sustainable alterations of performances." (Hug 2005, p. 4).

Depending on frames and domains of reference, micro, meso and macro aspects vary. They are relational concepts. For example, in the context of language learning, one might think of micro aspects in terms of vocabularies, phrases, sentences, and distinguish them from situations and episodes (meso aspects) and socio-cultural specifics or complex semantics (macro aspects). In a more general discourse on learning, one might differentiate between the learning of individuals, group learning or learning of organizations and the learning of generations or societies.

Furthermore, microlearning marks a transition from common models of learning towards micro perspectives on and the significance of micro dimensions in the process of learning. The microlearning approach is an emergent paradigm, so there are no hard definitions or coherent uses of the term yet. However, the growing focus on microlearning activities can be seen by web users' activities on the subject, who tag their corresponding weblog postings and social bookmarks with the term "microlearning" (check the corresponding Technorati anddel.icio.us tags for examples).

As an instructional technology, microlearning focuses on the design of microlearning activities through micro steps in digital media environments, which already is a daily reality for today's knowledge workers. These activities can be incorporated in learner's daily routines and tasks. Unlike "traditional" e-learning approaches, microlearning often tends towards push technology through push media, which reduces the cognitive load on the learners. Therefore, the selection of micro learning objects and also pace and timing of microlearning activities are of importance for didactical designs.

1.2 Characterization of microlearning

Microlearning can be characterized as follows:

- Microlearning processes often derive from interaction with microcontent, which takes place either in designed (media) settings (e-learning) or in emergent microcontent structures like weblog postings or social bookmark managers on the World Wide Web (Mosel 2005).
- Microlearning can be an assumption about the time needed to solve a learning task, for example answering a question, memorizing an information item, or finding a needed resource (Masie 2006). Learning processes that have been called "microlearning" can cover a span from few seconds (e.g. in mobile learning) up to 15 minutes or more. There is some relation to the term microteaching, which is an established practice in teacher education.
- Microlearning can also be understood as a process of subsequent, "short" learning activities, i.e. learning through interaction with microcontent objects in small timeframes. In this case, the design, selection, feedback and pacing of repeated or otherwise "chained" microlearning tasks comes into view.
- In a wider sense, microlearning is a term that can be used to describe the way more and more people are actually doing informal learning and gaining knowledge in microcontent,micromedia or multitasking environments (microcosm), especially those that become increasingly based on Web 2.0 and wireless web technologies. In this wider sense, the borders between microlearning and the complementary concept of microknowledge are blurring.

1.3 Dimensions of microlearning

The following dimensions can be used to describe or design microlearning activities:

- **Time:** relatively short effort, operating expense, degree of time consumption, measurable time, subjective time, etc.
- **Content:** small or very small units, narrow topics, rather simple issues, etc.
- **Curriculum:** small part of curricular setting, parts of modules, elements of informal learning, etc.
- **Form:** fragments, facets, episodes, "knowledge nuggets", skill elements, etc.
- **Process:** separate, concomitant or actual, situated or integrated activities, iterative method, attention management, awareness (getting into or being in a process), etc.
- **Mediality:** print media, electronic media, mono-media vs. multi-media, (inter-)mediated forms, etc.
- **Learning type:** repetitive, activist, reflective, pragmatist, conceptionalist, constructivist, connectivist, behaviorist; also: action learning, classroom learning, corporate learning, etc.

1.4 Examples of microlearning activities

- reading a paragraph of text, e-mail or sms

- listening to an informational (short) podcast or an educational video-clip
- viewing a flashcard
- memorizing a word, vocabulary, definition or formula
- sorting a set of (microcontent) items by (chrono)logical order
- selecting an answer to a question
- answering questions in quizzes
- playful learning with micro-games
- composing a haiku or a short poem

1.5 Microlearning applications (examples)

- Screensavers which prompt the user to solve small series of simple tasks after a certain amount of inactivity

- Quizzes with multiple choice options on cell phones by use of sms or mobile applications (java midlets, symbian)
- Word of the day as daily RSS-feed or e-mail
- Flashcard-software for memorizing content through spaced repetition

1.6 Microcontent

There are at least two interpretations of the term microcontent. Usability adviser Jakob Nielsen originally referred to microcontent as small groups of words that can be skimmed by a person to get a clear idea of the content of a Web page. He included article headlines, page titles, subject lines and e-mail headings.

Such phrases also may be taken out of context and displayed on a directory, search result page, bookmark list, etc. The second use of the term extends it to other small information chunks that can stand alone or be used in a variety of contexts, including instant messages, blog posts, RSS feeds, and abstracts

1.6.1 Original meaning

The original meaning of microcontent is by usability adviser Jakob Nielsen, who in a 1998 article referred to Microcontent as short content, like headlines, which need to be immediately clear and inviting to a reader, and which still make sense when removed from their original context. For instance, on a search engine result page, the article headline may be displayed with only a short snippet but not the full article.

"Microcontent should be an ultra-short abstract of its associated macrocontent," Nielsen said. He discourages traditional newspaper headline techniques, such as puns, teasers and other wordplay, which are more effective when the full story is already visible. He views the first word or two of each headline as extremely important to readers scanning a page.

1.6.2 Other meanings

The second meaning of the term has been defined by blogger Anil Dash in 2002:

"Today, microcontent is being used as a more general term indicating content that conveys one primary idea or concept, is accessible through a single definitive URL or permalink, and is appropriately written and formatted for presentation in email clients, web browsers, or on handheld devices as needed.

A day's weather forcast, the arrival and departure times for an airplane flight, an abstract from a long publication, or a single instant message can all be examples of microcontent."

In the years of the booming blogosphere the term became important and useful to describe the emerging new content structures that were enabled by new technologies (like trackbacks, pings and increasingly RSS), new types of CMS-software and -interfaces (like blogs and wikis), and not least by new socio-cultural practices (people creating, bringing into circulation and re-using/re-mixing microchunks of content).

Microcontent could be other forms of media like an image, audio, video, a URL (hyperlink), Metadata like author, title, etc, the subject line of an email, an item in an RSS feed. In 1998, Jakob Nielsen offered tips on how to write usable microcontent.

1.7 Microformat

A microformat (sometimes abbreviated μF) is a web-based approach to semantic markup which seeks to re-use existing HTML/XHTML tags to convey metadata and other attributes in web pages and other contexts that support (X)HTML, such as RSS.

This approach allows software to process information intended for end-users (such as contact information, geographic coordinates, calendar events, and the like) automatically.

Although the content of web pages is technically already capable of "automated processing", and has been since the inception of the web, such processing is difficult because the traditional markup tags used to display information on the web do not describe what the information means.

Microformats can bridge this gap by attaching semantics, and thereby obviate other, more complicated, methods of automated processing, such as natural language processing or screen scraping.

The use, adoption and processing of microformats enables data items to be indexed, searched for, saved or cross-referenced, so that information can be reused or combined.

As of 2010 microformats allow the encoding and extraction of events, contact information, social relationships and so on. More are being developed.

1.7.1 Background

Microformats emerged as part of a grassroots movement to make recognizable data items (such as events, contact details or geographical locations) capable of

automated processing by software, as well as directly readable by end-users.Link-based microformats emerged first.

As the microformats community grew, CommerceNet, a nonprofit organization that promotes electronic commerce on the Internet, helped sponsor and promote the technology and support the microformats community in various ways. CommerceNet also helped co-found the Microformats.org community site.

Neither CommerceNet nor Microformats.org operates as a standards body. The microformats community functions through an open wiki, a mailing list, and an Internet relay chat (IRC) channel.

Most of the existing microformats were created at the Microformats.org wiki and the associated mailing list, by a process of gathering examples of web publishing behaviour, then codifying it.

Some other microformats (such as rel=nofollow and unAPI) have been proposed, or developed, elsewhere.

1.7.2 Plain Old Semantic HTML (POSH)

The phrase "plain old semantic HTML" appeared online as early as 1998, but the coinage of the acronym POSH used in connection with microformats occurred in April 2007 on the microformats irc channel. Semantic HTML focuses on the use of tags and attributes for semantic rather than presentational purposes.

Its proponents discourage the use of tables for layout (see Tableless web design) and the use of the <b> or
 tags since these tags are purely presentational

1.7.3 Specific microformats

Several microformats have been developed to enable semantic markup of particular types of information.

- hAtom – for marking up Atom feeds from within standard HTML
- hCalendar – for events
- hCard – for contact information; includes:
- adr – for postal addresses
- geo – for geographical coordinates (latitude, longitude)
- hMedia - for audio/video content
- hNews - for news content
- hProduct – for products
- hRecipe - for recipes and foodstuffs.
- hResume – for resumes or CVs
- hReview – for reviews
- rel-directory – for distributed directory creation and inclusion

- rel-enclosure – for multimedia attachments to web pages
- rel-license – specification of copyright license
- rel-nofollow, an attempt to discourage third-party content spam (e.g. spam in blogs)
- rel-tag – for decentralized tagging (Folksonomy)
- xFolk – for tagged links
- XHTML Friends Network (XFN) – for social relationships
- XOXO – for lists and outlines

1.7.4 Microformats under development

Among the many proposed microformats, the following are undergoing active development:

- hAudio – for audio files and references to released recordings
- citation – for citing references
- currency – for amounts of money
- figure – for associating captions with images
- geo extensions – for places on Mars, the Moon, and other such bodies; for altitude; and for collections of waypoints marking routes or boundaries
- species – For the names of living things (already used by Wikipedia and the BBC Wildlife Finder)
- measure – For physical quantities, structured data-values

1.7.5 Uses of microformats

Using microformats within HTML code provides additional formatting and semantic data that applications can use. For example, applications such as web crawlers can collect data about on-line resources, or desktop applications such as e-mail clients or scheduling software can compile details.

The use of microformats can also facilitate "mash ups" such as exporting all of the geographical locations on a web page into (for example) Google Maps to visualize them spatially.

Several browser extensions, such as Operator for Firefox and Oomph for Internet Explorer, provide the ability to detect microformats within an HTML document. When hCard or hCalendar are involved, such browser extensions allow to export them into formats compatible with contact management and calendar utilities, such as Microsoft Outlook.

When dealing with geographical coordinates, they allow to send the location to maps applications such as Google Maps. Yahoo! Query Language can be used to extract microformats from web pages. On 12 May 2009, Google announced that they

would be parsing the hCard, hReview and hProduct microformats, and using them to populate search result pages.

They have since extended this to use hCalendar for events and hRecipe for cookery recipes.

Microsoft expressed a desire to incorporate Microformats into upcoming projects; as have other software companies.

Alex Faaborg summarizes the arguments for putting the responsibility for microformat user interfaces in the web browser rather than making more complicated HTML:

- Only the web browser knows what applications are accessible to the user and what the user's preferences are
- It lowers the barrier to entry for web site developers if they only need to do the markup and not handle "appearance" or "action" issues
- Retains backwards compatibility with web browsers that don't support microformats
- The web browser presents a single point of entry from the web to the user's computer, which simplifies security issues

1.7.6 Evaluation of microformats

Various commentators have offered review and discussion on the design principles and practical aspects of microformats. Additionally, microformats have been compared to other approaches that seek to serve the same or similar purpose. From time to time, there is criticism of a single, or all, microformats.

Documented efforts to advocate both the spread and use of microformats are known to exist as well. Opera Software CTO and CSS creator Håkon Wium Lie said in 2005

"We will also see a bunch of microformats being developed, and that's how the semantic web will be built, I believe."

However, as of August 2008, Toby Inkster, author of the "Swignition" (formerly "Cognition") microformat parsing service pointed out that no new microformat specifications had been published for over three years.

1.7.7 Design principles

Computer scientist and entrepreneur, Rohit Khare stated that reduce, reuse, and recycle is "shorthand for several design principles" that motivated the development and practices behind microformats.

These aspects can be summarized as follows:

- Reduce: favor the simplest solutions and focus attention on specific problems;

- Reuse: work from experience and favor examples of current practice;
- Recycle: encourage modularity and the ability to embed, valid XHTML can be reused in blog posts, RSS feeds, and anywhere else you can access the web.

1.7.8 Accessibility

Because some microformats make use of title attribute of HTML's abbr element to conceal machine-readable data (particularly date-times and geographical coordinates) in the "abbr design pattern", the plain text content of the element is inaccessible to those screen readers that expand abbreviations.

In June 2008, the BBC announced that it would be dropping use of microformats using the abbr design pattern because of accessibility concerns.

1.7.9 Comparison with alternative approaches

Microformats are not the only solution for providing "more intelligent data" on the web. Alternative approaches exist and are under development as well. For example, the use of XML markup and standards of the Semantic Web are cited as alternative approaches.

Some contrast these with microformats in that they do not necessarily coincide with the design principles of "reduce, reuse, and recycle", at least not to the same extent.

One advocate of microformats, Tantek Çelik, characterized a problem with alternative approaches:

> Here's a new language we want you to learn, and now you need to output these additional files on your server. It's a hassle. (Microformats) lower the barrier to entry.

For some applications the use of other approaches may be valid. If one wishes to use microformat-style embedding but the type of data one wishes to embed does not map to an existing microformat, one can use RDFa to embed arbitrary vocabularies into HTML, for example: embedding domain-specific scientific data on the Web like zoological or chemical data where no microformat for such data exists.

Furthermore, standards such as W3C's GRDDL allow microformats to be converted into data compatible with the Semantic Web.

Another advocate of microformats, Ryan King, put the compatibility of microformats with other approaches this way:

> Microformats provide an easy way for many people to contribute semantic data to the web. With GRDDL all of that data is made available for RDF Semantic Web tools. Microformats and GRDDL can work together to build a better web.

1.8 Microlecture

The term microlecture is used not to refer to microcontent for microlearning, but to actual instructional content that is formatted for online and mobile learning using a constructivist approach.

More specifically, as described in the Chronicle of Higher Education, these are approximately 60 second presentations with a specific structure.

They are not just brief (one minute) presentations: although Dr. McGrew had success with "one minute lectures" at the University of Northern Iowa as did Dr. Kee at the University of Leeds.

David M. Penrose (aka the One Minute Professor), the Senior Instructional Designer and Manager of Online Services at San Juan College, of SunGard Higher Education has articulated the process for creating these microlectures. As stated (Shieh, 2009), these specific lectures are combined with specific activities designed to promote the epistemic engagement of the learner.

The response of the Higher Education community was mixed, with some positive and some negative.

The interest surrounding the use of microlectures has continued to grow, even outside of the United States, to places like Hong Kong University. In the United States, the use of microlectures are even considered a vital part of the Pandemic Response Plans. Additionally, even scholars at schools like Princeton University (Humanities Resource Center) and UNC's School of Government, support the importance of an innovative teaching-learning approach for learners in the 21st century.

1.8.1 How to create a One Minute Lecture

Professors spend a lot of time crafting hourlong lectures. The prospect of boiling them down to 60 seconds — or even five minutes — may seem daunting. David Penrose, a course designer for SunGard Higher Education who developed San Juan College's microlectures, suggests that it can be done in five steps:

- List the key concepts you are trying to convey in the 60-minute lecture. That series of phrases will form the core of your microlecture.
- Write a 15 to 30-second introduction and conclusion. They will provide context for your key concepts.
- Record these three elements using a microphone and Web camera. (Your information-technology department can provide advice and facilities.) If you want to produce an audio-only lecture, no Webcam is necessary. The finished product should be 60 seconds to three minutes long.
- Design an assignment to follow the lecture that will direct students to readings or activities that allow them to explore the key concepts. Combined with a written assignment, that should allow students to learn the material.

- Upload the video and assignment to your course-management software.

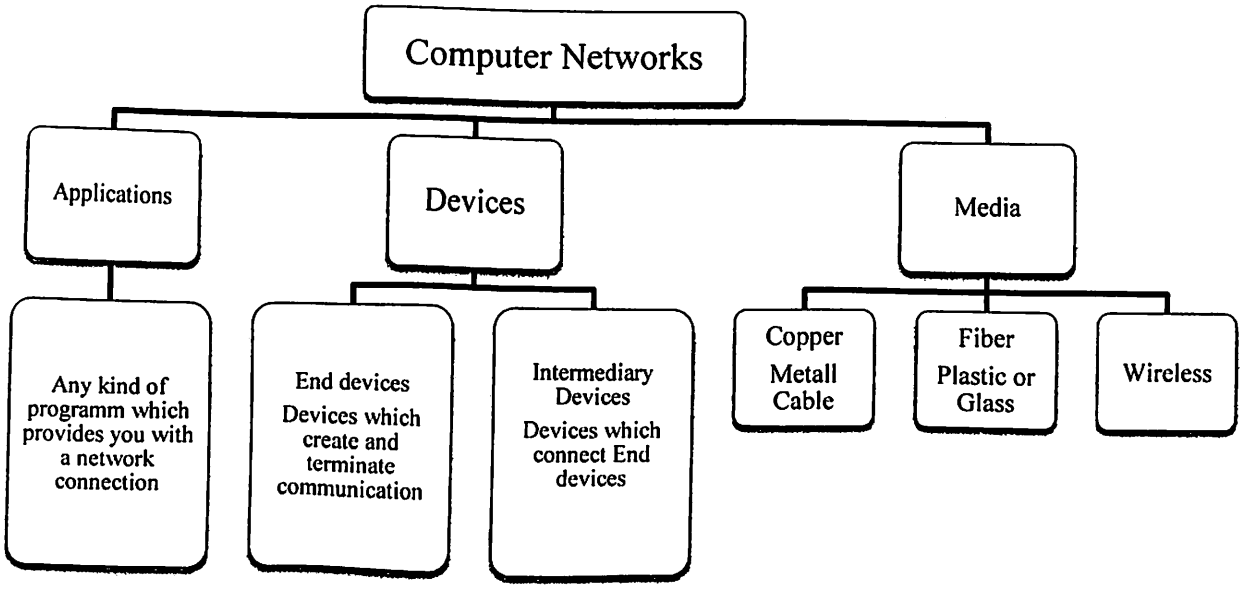
2 COMPUTER NETWORKS IN MICROLEARNING STYLE

2.1 Lesson 1

Main Parts of Computer Networks

Computer Networks consist of three main parts:

1. Applications
2. Devices
3. Media



1. Application example: Skype, Gtalk, MSN Messenger etc.
2. Devices:
   - End device example: PC (computer), network printer, server etc.
   - Intermediary device example: Switch, router, hub
3. Media:
   - Copper media example: UTP, STP,
   - Fiber media example: Fiber cable
   - Wireless media example: Air

2.2 Lesson 2

Types of Computer Networks

1. **PAN** –Personal Area Network (the very close area, example: Bluetooth)
2. **LAN** – Local Area Network (Single geographical area, example: Enterprise network)
3. **MAN** – Metropolitan Area Network (Medium size geographical area, example: Disctrict connection)

4. **WAN** – Wide Area Network (Long distance connection, example: Interconnection between cities)
5. **Internet**- Global interconnection of LANs, MANs and WANs
6. **Intranet** – Private Interconnection between LANs, MANs and WANs.

In figure 0:1 you can see graphical representation of Computer Networks Types.

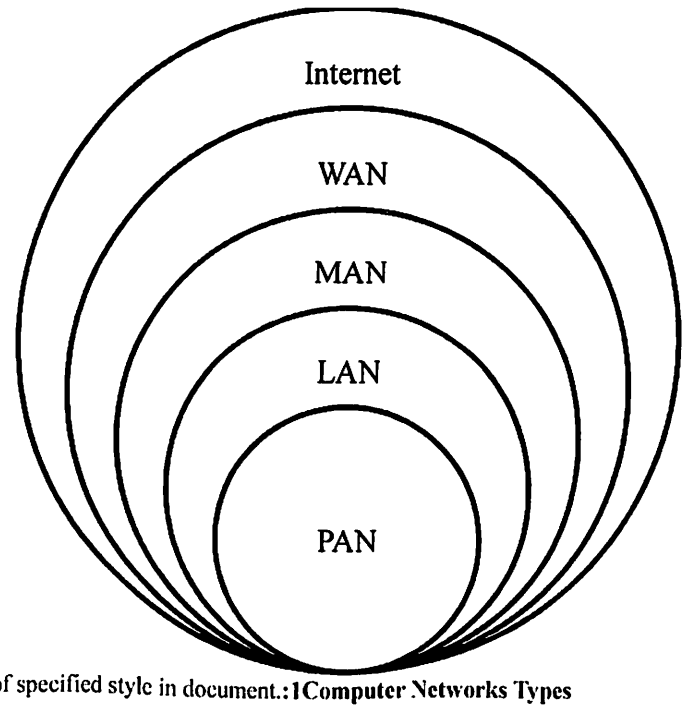


Figure Error! No text of specified style in document.:1**Computer Networks Types**

Conversation rules (Protocols)

In making conversation people use some rules. Computers also use some rules in making communication. Let us discuss some basic human conversation rules:

1. Before starting conversation say "Hello" and before finishing it, say "good bye".
2. When you speak to someone, that person has to listen to you and vice-versa, when someone speaks to you, you have to listen.
3. Both of the people having a conversation, have to know a common language

In Computer Networks these rules are called **Protocols.**

Protocol – is a set of rules.

Standards of Computer Networks protocols are developed by **IEEE** (Institute of Electrical and Electronics Engineers) and **IETF** (Internet Engineering Task Force)

2.3 Lesson 3

Segmentation (division) of data rule

I think that one of the easiest ways of describing Network Protocols would be through some examples.

In this example user Client is going to send 50 MB of data to Server, but before doing that Client have to divide data into small parts. What for?

To answer this question let us describe problems which can occur during this transportation

1. Media may be fully busy; it means that only one computer would be able to send or receive the data at the same time.
2. If during transportation some bits are lost, client will have to resend the whole 50 MB to server again.

In figure 0:2 you can see representation of data sending process without division.

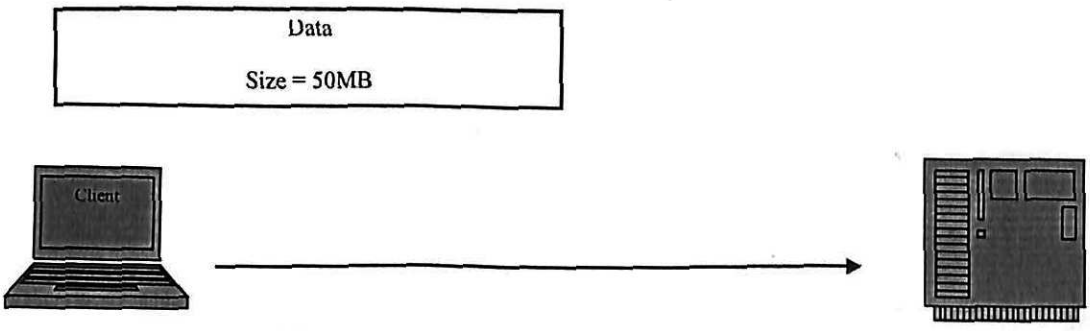


Figure Error! No text of specified style in document.**:2 Sending data without division**

In figure 0:3 you can see representation of data sending with division.

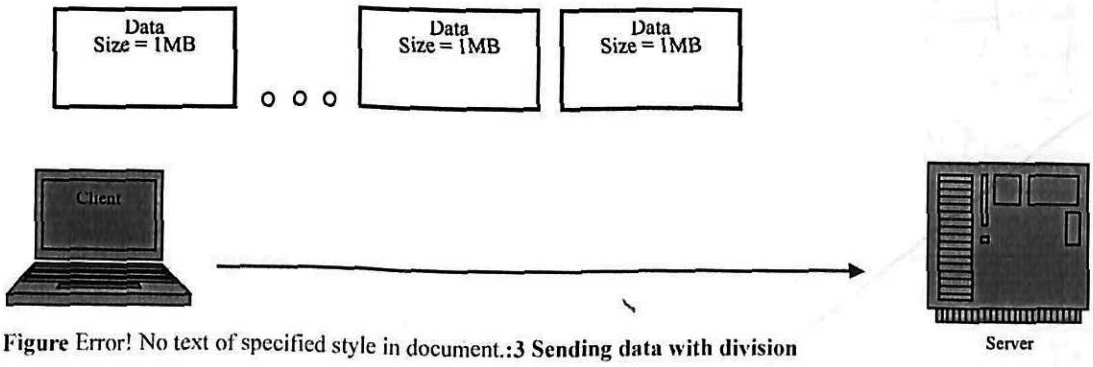


Figure Error! No text of specified style in document.**:3 Sending data with division**

Multiplexing

Next, what will happen if two or more PCs use the same media at the same time?

Answer: Collision will happen on the media. To improve the problem, Computer Networks have mechanism which is called **Multiplexing**. Figure 0:4 show how packages can make collision.

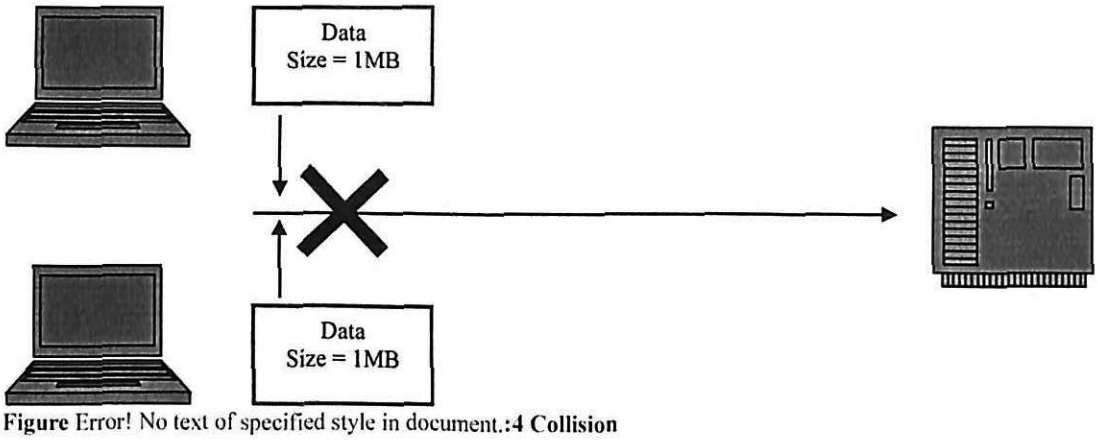


Figure Error! No text of specified style in document.**:4 Collision**

Labeling (giving sequence)

One more rule of communication in Computer Networks is **Labeling Process**. Receiving device has to define a sequence of each part of information, because receiving device can receive them in random order due to different paths usage. After receiving them in wrong sequence, computer stores them in cash memory, improves the sequence and after that sends data to application. Figure 0:5 show labeling.

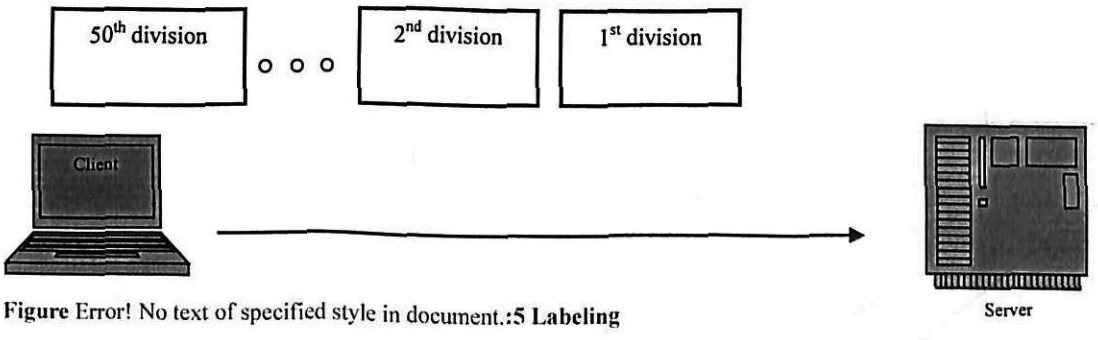


Figure Error! No text of specified style in document.**:5 Labeling**

2.4 Lesson 4

Networking Layered Model

One of the easiest ways to understand Computer Networks is to divide different types of protocols (rules) by their functionality and responsibilities.
Networking Layered Model

- Is the way of understanding the network structure
- No matter which model you use, you are speaking about the same network
- The model is not actual network

Currently we are using two models, they are: OSI (Open System Interconnections) and TCP/IP models. The first Layered model was TCP/IP model, which consists of four layers, whereas OSI consist of seven layers. Figure 0:6 shows structure of Computer Networks model.

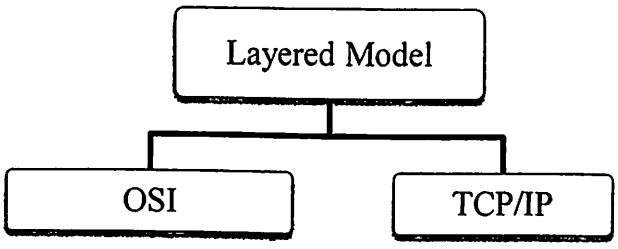


Figure Error! No text of specified style in document.:6 Layered Model Structure

TCP/IP model – 4 layers

Each of the layers is responsible for different types of operations. Figure 0:7 shows TCP/IP model.

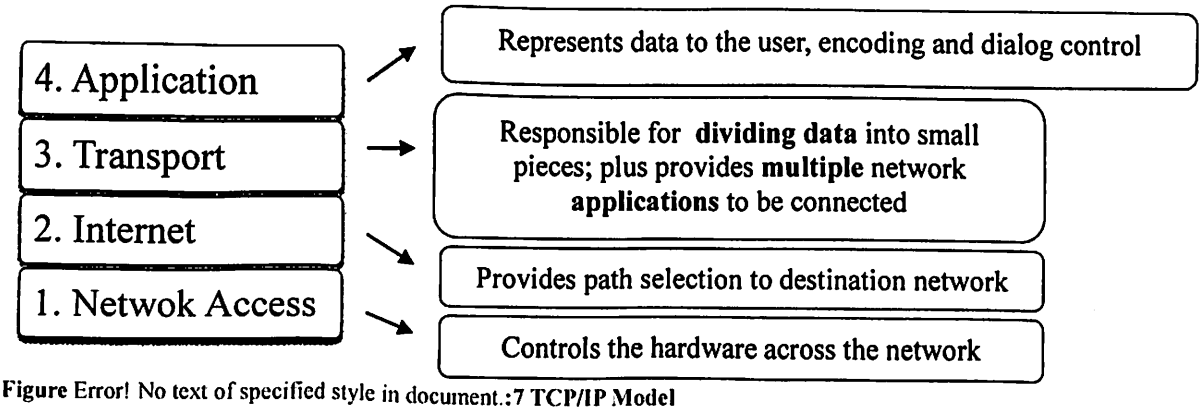


Figure Error! No text of specified style in document.:7 TCP/IP Model

OSI (Open System Interconnections) model – 7 layers

We are going to discuss OSI Model later in this chapter. Figure 0:8 show OSI Model.

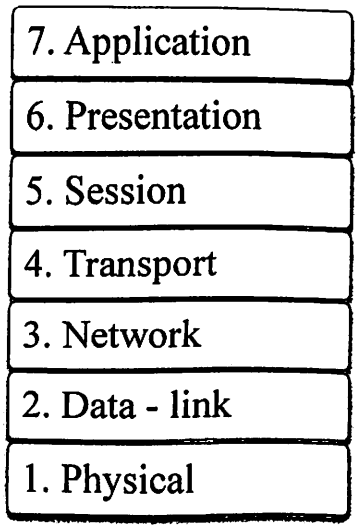


Figure Error! No text of specified style in document.:8 OSI Model

Comparison of OSI and TCP/IP Models

In comparison of two OSI and TCP/IP models we can see that 7th Application, 6th Presentation and 5th Session Layers of OSI model are division of 4th Application layer of TCP/IP model.
4th Transport layer of OSI is equal to 3rd Transport of TCP/IP model, 3rd Network layer same as 2nd Internet layer of TCP/IP model. 2nd Data-Link and 1st Physical Layer are equal to functionality of 1st Network Access Layer of TCP/IP model. Figure 0:9 show comparison of TCP/IP and OSI Models.

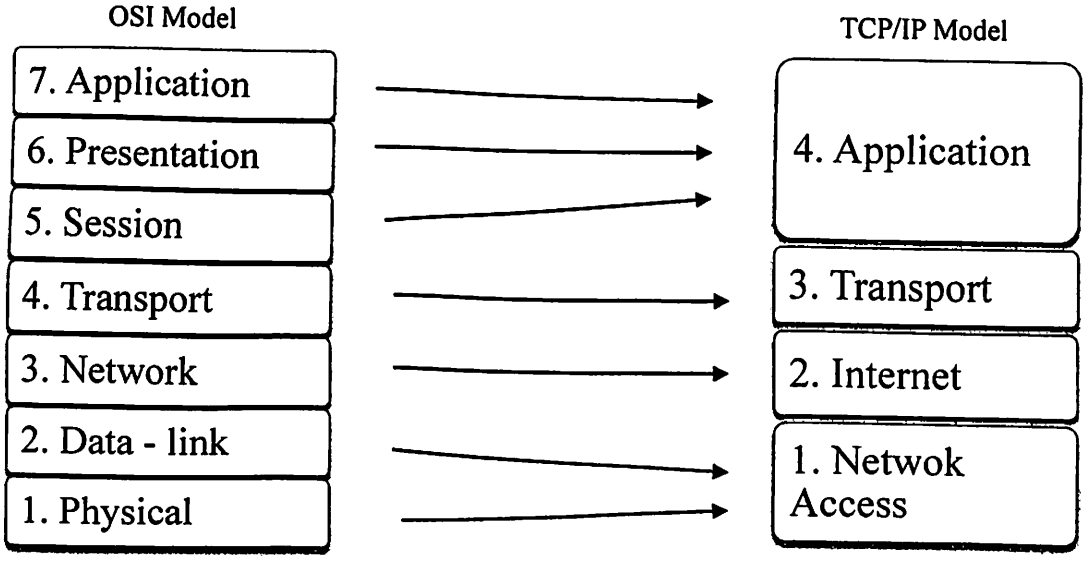


Figure Error! No text of specified style in document.:9 Comparison of Networking Models

2.5 Lesson 5

Application layer of TCP Model and Application, Presentation and Session Layers of OSI Model

Application Layer (OSI) – The Application layer, Layer seven, is the top layer of both the OSI and TCP/IP models. It is the layer that provides the interface between the applications we use to communicate and the underlying network, over which our messages are transmitted. Application layer protocols are used to exchange data between programs running on the source and destination hosts. There are many Application layer protocols and new protocols are always being developed.
Also, name comes from the program, so it means that at this layer we can see programs which give as availability to make communication.
Example: Skype, Gtalk, MSN Messenger and MAgent.

Presentation Layer of OSI Model

As you know in computer system we have different types of files, example: mp3, PDF, GIF... And each of this file types must be encrypted and compressed in

different ways. Presentation Layer is responsible for encryption and compression of different types of files before sending data and after receiving data.

Session Layer of OSI Model

As the name of the Session layer implies, functions at this layer create and maintain dialogs between source and destination applications. The Session layer handles the exchange of information to initiate dialogs, keeps them active, and restarts sessions that are disrupted or idle for a long period of time.

Transport Layer

Transport Layer is responsible for defining the application to which data has to be received and from which application data leaves the computer. Also Transport Layer makes management of data transportation.

Network Layer

Is responsible for finding out the network where or to which data has been sent.

Data-Link Layer

Responsible for Media Access Control, means that it controls how data inserted into the Media (cable).

Physical Layer

Responsible for converting data into the electrical, optical and electromagnetic signals.

2.6 Lesson 6

Communication Process

As the name of the Session layer implies, functions at this layer create and maintain dialogs between source and destination applications. The Session layer handles the exchange of information to initiate dialogs, keeps them active, and restarts sessions that are disrupted or idle for a long period of time. Figure 0:10 show communication process

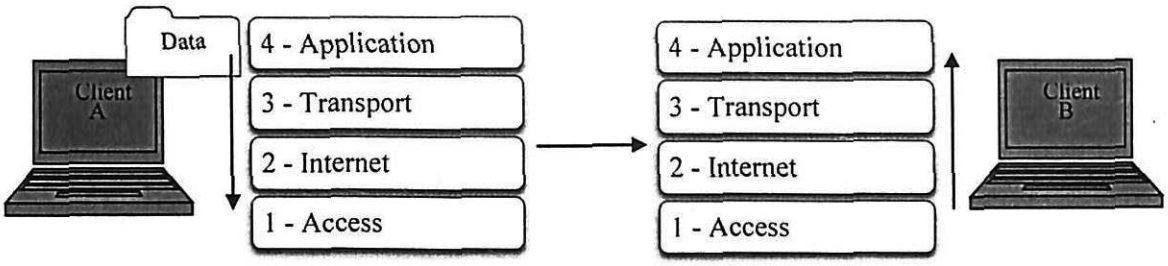


Figure Error! No text of specified style in document.:**10 Communication process**

In this example "Client A" is going to send data to "Client B". A complete communication process includes these steps:

1. Creation of data at the application layer of the originating source end device
2. Segmentation and encapsulation of data as it passes down the protocol stack in the source end device
3. Generation of the data onto the media at the network access layer of the stack
4. Transportation of the data through the internetwork, which consists of media and any intermediary devices
5. Reception of the data at the network access layer of the destination end device
6. Decapsulation and reassembly of the data as it passes up the stack in the destination device
7. Passing this data to the destination application at the Application layer of the destination end device

Encapsulation

As application data is passed down the protocol stack on its way to be transmitted across the network media, various protocols add information to it at each level. This is commonly known as the encapsulation process.

Example of Communication Process.

"Client A" is going to make communication over the network. Figure 0:11 show encapsulation process.

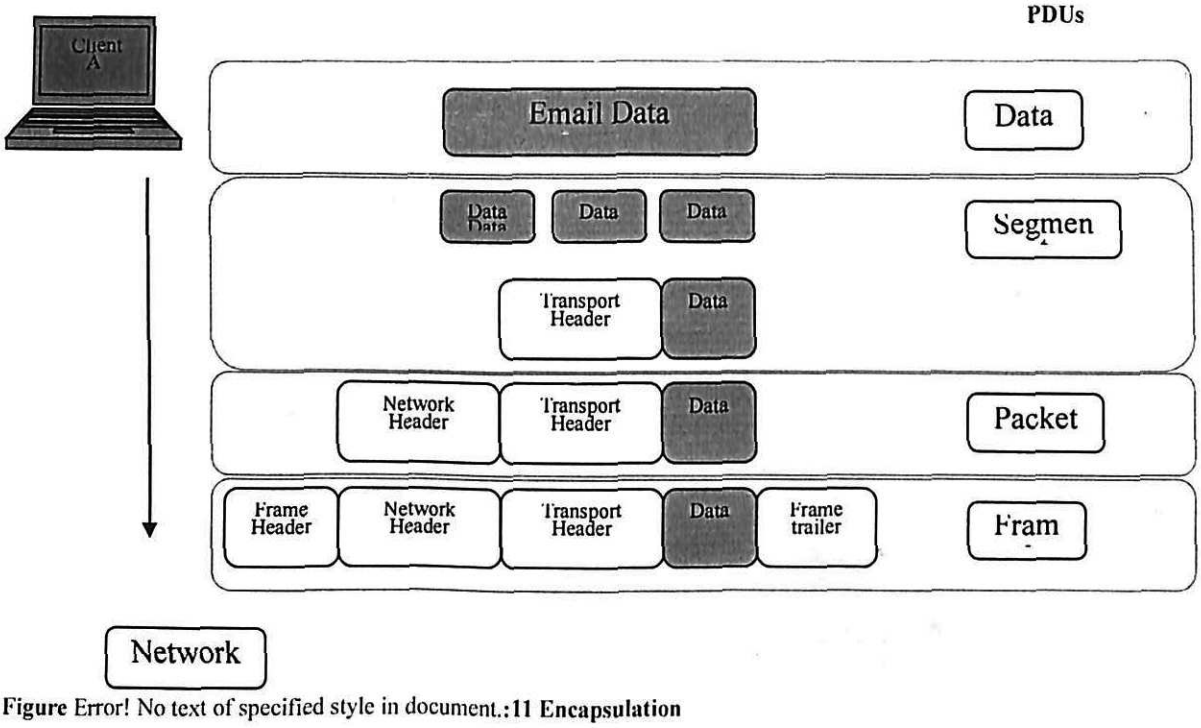


Figure Error! No text of specified style in document.:11 Encapsulation

Protocol Data Unit

Protocol Data Unit (PDU) - The form that a piece of data takes at any layer is called a Protocol Data Unit (PDU).

Here is the list of PDUs of TCP/IP layered model:

- Data - The general term for the PDU used at the Application layer
- Segment - Transport Layer PDU
- Packet - Internetwork Layer PDU
- Frame - Network Access Layer PDU
- Bits - A PDU used when physically transmitting data over the medium

2.7 Lesson 7

Application Layer

Most of us experience the Internet through the World Wide Web, e-mail services, and file-sharing programs. These applications, and many others, provide the human interface to the underlying network, enabling us to send and receive information with relative ease. Typically the applications that we use are intuitive, meaning we can access and use them without knowing how they work. However, for network professionals, it is important to know how an application is able to format, transmit and interpret messages that are sent and received across the network.

In other words it is a program layer.

In application layer we have protocols like: HTTP, SMTP, POP, DHCP and DNS

Like in human communication, Computer communication usually has two positions. 1st position: those who take service from someone, and 2nd position: those who provide service. Let us describe two models of communication in Computer Network.

The Client-Server Model

In this mode we can have many clients which are connected to one server. Single server can make service for many clients.

Client - device requesting the information is called a client.

Server - device responding to the request is called a server, also we can say that servers makes service for clients. Figure 0:12 show client-server model.

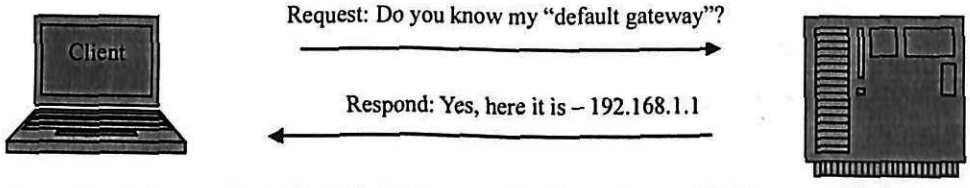


Figure Error! No text of specified style in document.:**12 Client - Server Model**

We can compare Client-Server model with front-desk worker. Usually they seat in front of the entrance door and every client firstly sees front-desk worker. It means that this worker is going to make service for many clients.

The Peer-to-Peer Model

In this kind of networking model every "Client" is a "Server" and every "Server" is a "Client". Figure 0:13 show peer-to-peer model.

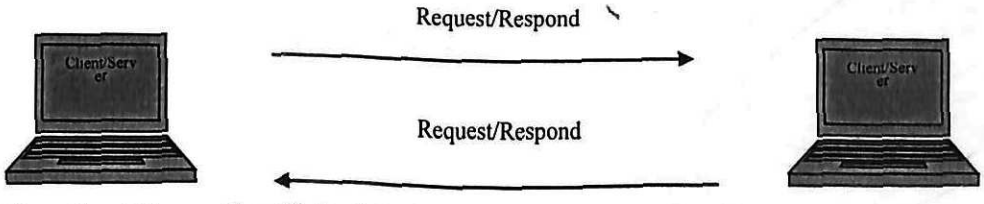


Figure Error! No text of specified style in document.:**13 Peer-to-Peer Model**

While people make communications they are listening and speaking, so we can say that when we are listening, we get information. When we are speaking we give information. When computer takes information it is called ***Download****, when computer gives information, it is called* ***Upload****.*

Upload and Download

Figure 0:14 show upload and download processes.

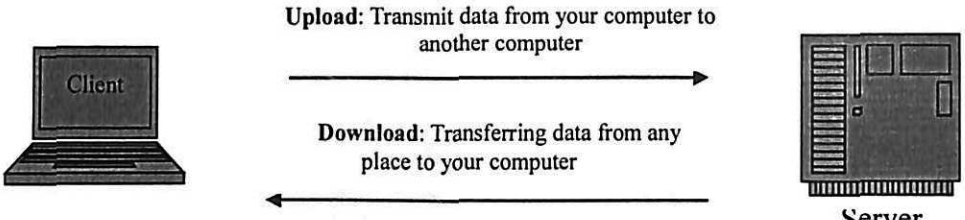


Figure Error! No text of specified style in document.**:14 Upload and download**

2.8 Lesson 8

Application Layer Protocols

Figure 0:15 show application layer protocols.

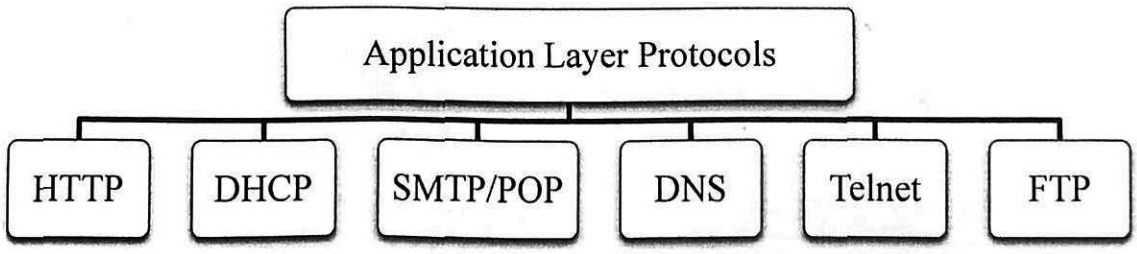


Figure Error! No text of specified style in document.**:15 Application Layer Protocols**

HTTP – Hypertext Transfer Protocol

Question: What is the meaning of the word "Hypertext"?
Hyper, Text?

Answer: All the texts and objects that are inside the browser are called Hypertext

Example of hypertext: In this picture you can see pictures, text and animation. All of it is called hypertext. Figure 0:16 show example of web site.

Figure Error! No text of specified style in document.**:16 Example of WEB Page (SDU official web site)**

HTTP Protocol is responsible for hypertext (web content) transportation. When web client opens web browser and types in URL the address like **www.sdu.edu.kz**, the web browser makes request to web server: Get "**index.html**" from **www.sdu.edu.kz.** And after that web server makes respond to client.

2.9 Lesson 9

DNS - Domain Name System

Each of us has a name and almost all of us have nicknames, for example: instead of "Berik" we can use "Bake", instead of "Serik" we can use "Seke".

Question: Why people use nickname?
Answer: Because nicknames are usually easier to remember.

Like in human life, in data networks, devices are labeled with numeric IP addresses (names), so that they can participate in sending and receiving messages over the network. However, most people have a hard time remembering this numeric address. Hence, domain names (nicknames) were created to convert the numeric address into a simple, recognizable name.
On the Internet these domain names, such as www.sdu.edu.kz (nickname), are much easier for people to remember than 88.123.111.21 (name), which is the actual numeric address for this server.

www.sdu.edu.kz – I can easily remember this name

88.99.11.12 – I can remember it, but not so easily

2.10 Lesson 10

How DNS Works?

In this example Berik is trying to open www.sdu.edu.kz web site. He is typing the domain name of SDU: www.sdu.edu.kz in to the URL of the browser and pressing "Enter", but his computer doesn't know numerical IP address of www.sdu.edu.kz domain name. And without this IP address he can't open that page.
So Berik's computer has to learn the IP address of that domain, by sending request to DNS server. If server has got the IP address of that domain, it will send respond with it. After that Berik will be able to open that web page. Figure 0:17 show DNS process.

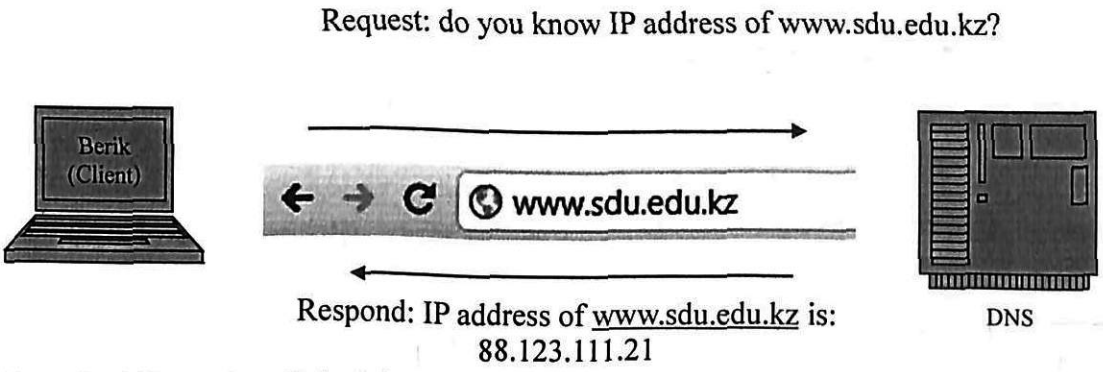


Figure Error! No text of specified style in document.**:17 DNS Process**

If you want to see the IP address of any domain name, open "CMD" application and type "nslookup" command, after what type domain name.
Figure 0:18 show output of command "NSLOOKUP".

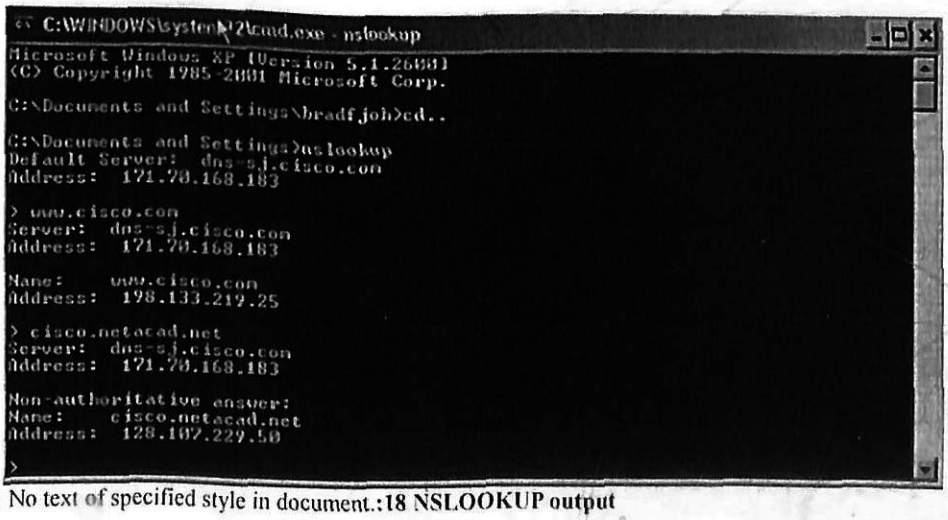


Figure Error! No text of specified style in document.**:18 NSLOOKUP output**

When a client makes a query, the server's "named" process first looks its own records to see if it can resolve the name. If it is unable to find out the name using its stored records, it contacts other servers in order to resolve the name.

The request may be passed along to a number of servers, which can take extra time and consume bandwidth. Once a match is found and returned to the original requesting server, the server temporarily stores the numbered address that matches the name in cache.
If that same name is requested again, the first server can return the address by using the value stored in its name cache. Caching reduces both the DNS query data network traffic and the workloads of servers higher up the hierarchy. The DNS Client service on Windows PCs optimizes the performance of DNS name resolution by storing previously resolved names in memory, as well.
The Domain Name System uses a hierarchical system to create a name database to provide name resolution. The hierarchy looks like an inverted tree with the root at the top and branches below.
At the top of the hierarchy, the root servers maintain records about how to reach the top-level domain servers, which in turn have records that point to the secondary level domain servers and so on.
The different top-level domains represent either the type of organization or the country of origin. Examples of top-level domains are:

- .kz -Kazakhstan
- .com - a business or industry
- .org - a non-profit organization

After top-level domains are second-level domain names, and below them are other lower level domains.
Each domain name is a path down this inverted tree starting from the root. Figure 0:19 show DNS hierarchy.

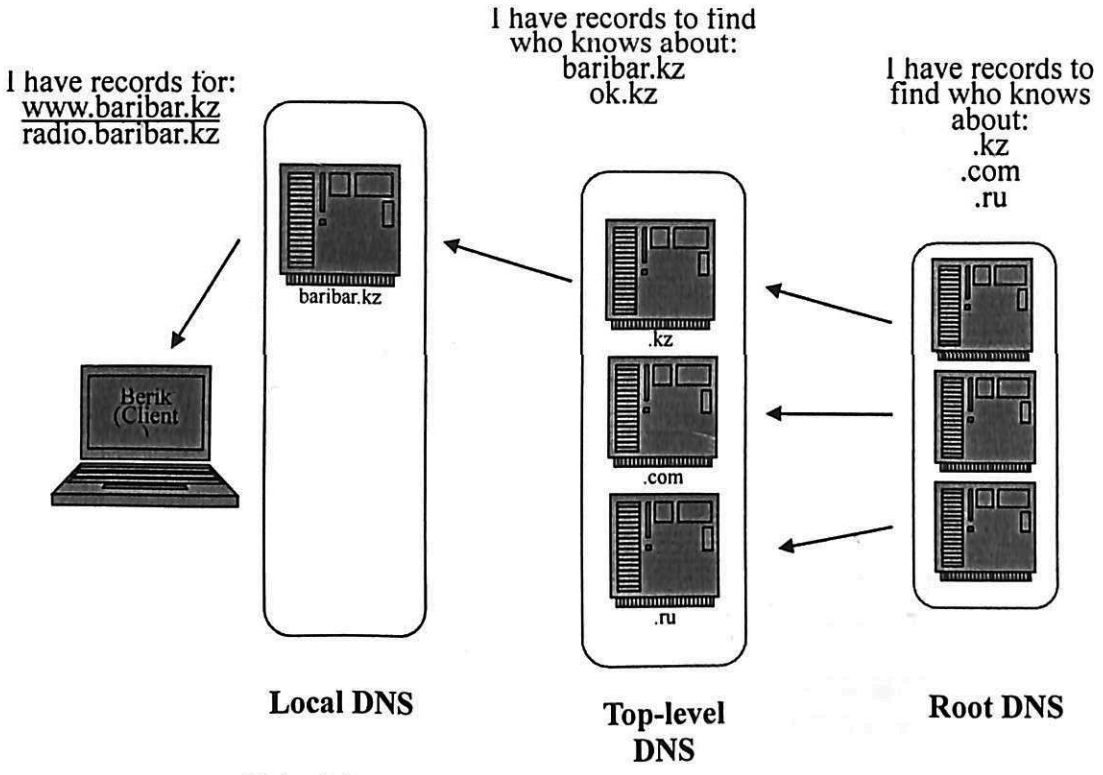
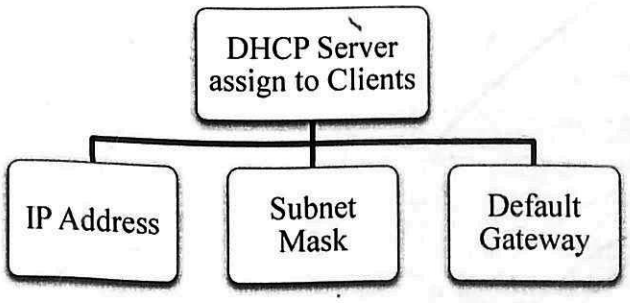


Figure Error! No text of specified style in document.:19 DNS hierarchy

2.11 Lesson 11

DHCP – Dynamic Host Configuration Protocol

If a client wants to connect to a network he must have at least an "IP address", a "Subnet Mask" and a "Default Gateway" to be configured.
Without DHCP, users have to manually input configurations.



DHCP allows a host to obtain an IP address dynamically when it connects to the network. The DHCP server is contacted and an address requested. The DHCP server chooses an address from a configured range of addresses called a pool and assigns ("leases") it to the host for a set period.
To easily understand this protocol let us take a look for the DHCP four step process

Four Steps of DHCP Process

1st step: Client connects to a network without "IP address", "Subnet Mask" and "Default Gateway" but with DHCP client. After that, it starts to send DHCP Discovery (I am looking for DHCP server) packet to find out DHCP server.

2nd step: Server receives DHCP Discovery packets from client and sends offer (I am DHCP Client) to client.

3rd step: Client receives offer and sends DHCP Request (Give me "IP address", "Subnet Mask" and "Default Gateway").

4th step: Server receives request and sends DHCP Acknowledgement ("IP address", "Subnet Mask" and "Default Gateway") to client. Figure 0:20 show DHCP process.

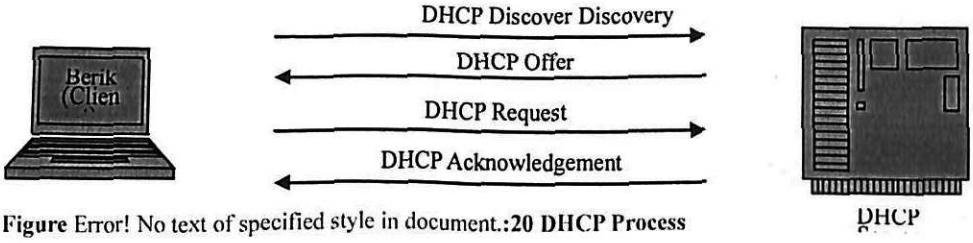


Figure Error! No text of specified style in document.**:20 DHCP Process**

2.12 Lesson 12

Telnet/SSH Protocols

Both of these protocols give you ability to a remote control of the computer. Example of application can be "putty". Difference between Telnet and SSH is in security, SSH (Secure Shell) is more securable, because it makes encryption all of the data. Telnet sends data in plain text (without encryption).

SMTP/POP – Simple Mail Transfer Protocol/Post Office Protocol

E-mail, the most popular network service, has revolutionized the way people communicate through its simplicity and speed. Yet to run on a computer or other end device, e-mail requires several applications and services. Two example Application layer protocols are Post Office Protocol (POP) and Simple Mail Transfer Protocol (SMTP), shown in the figure. As with HTTP, these protocols define client/server processes. Figure 0:21 show e-mail protocols in action.

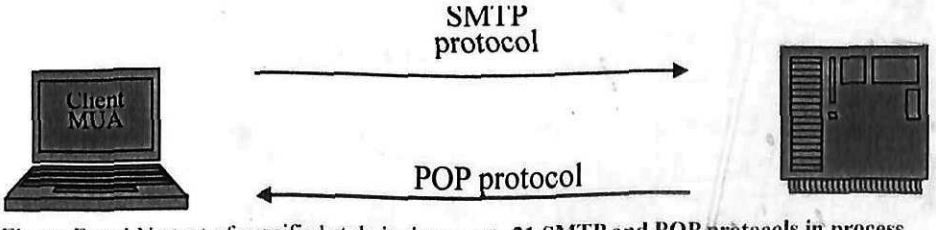


Figure Error! No text of specified style in document.**:21 SMTP and POP protocols in process**

Client is using Application which is called **MUA** - Mail User Agent. Figure 0:22 show MUA with e-mail protocols.

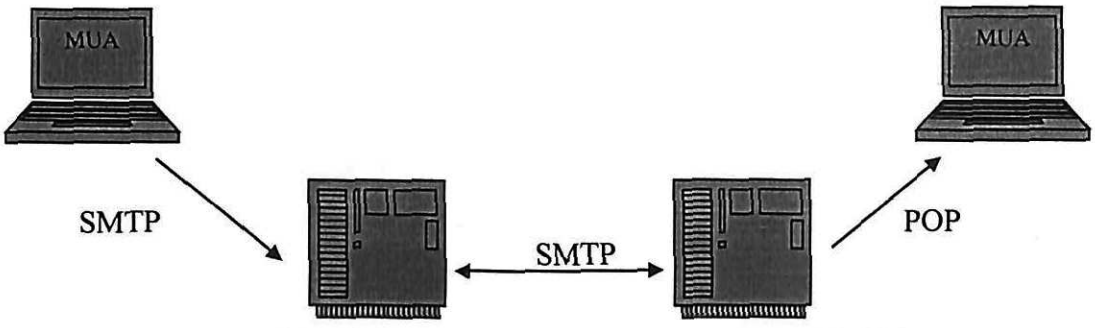


Figure Error! No text of specified style in document.**:22 SMTP and POP protocols with MUA**

Server that is resending message to another server use app. **MTA**
Server that is resending message to recipient use app. **MDA**

2.13 Lesson 13

Transport Layer

In this chapter, we examine the role of the Transport layer in encapsulating application data for use by the Network layer. The Transport layer also encompasses these functions:

- Enables multiple applications to communicate over the network at the same time on a single device
- Divides data into segments
- Ensures that, if required, all the data is received reliably and in order by the correct application

Figure 0:23 show Roles of Transport Layer.

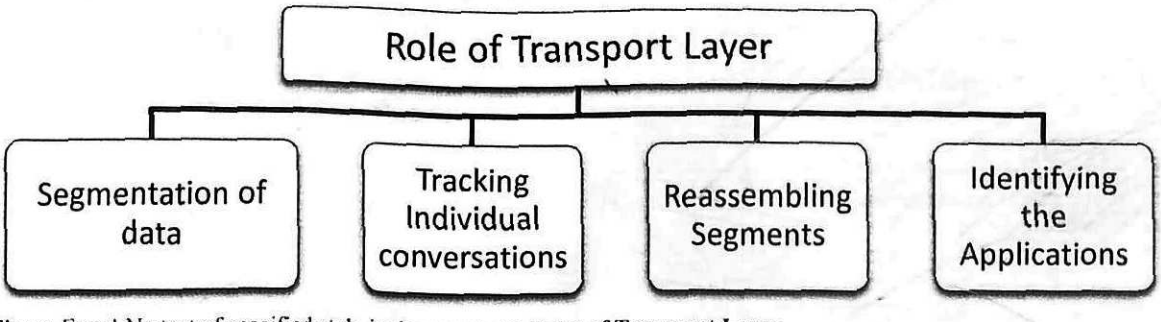


Figure Error! No text of specified style in document.**:23 Roles of Transport Layer**

2.14 Lesson 14

Segmentation of Data

As each application creates a stream data to be sent to a remote application, this data has to be prepared to be sent across the media in manageable pieces. Transport Layer makes segmentation process for easier transportation, because if we send data in one stream, that data will fully load the media.

- The Transport layer protocols describe services that segment data from the Application layer.

- This includes the encapsulation, required for each piece of data.
- Each piece of application data requires headers to be added at the Transport layer to indicate to which communication it is associated.

Firstly we have to understand meaning of word ***Encapsulation.***

Encapsulation is the process of preparing data before placing into the media
Figure 0:24 show encapsulation process.
Example of encapsulation in Transport Layer:

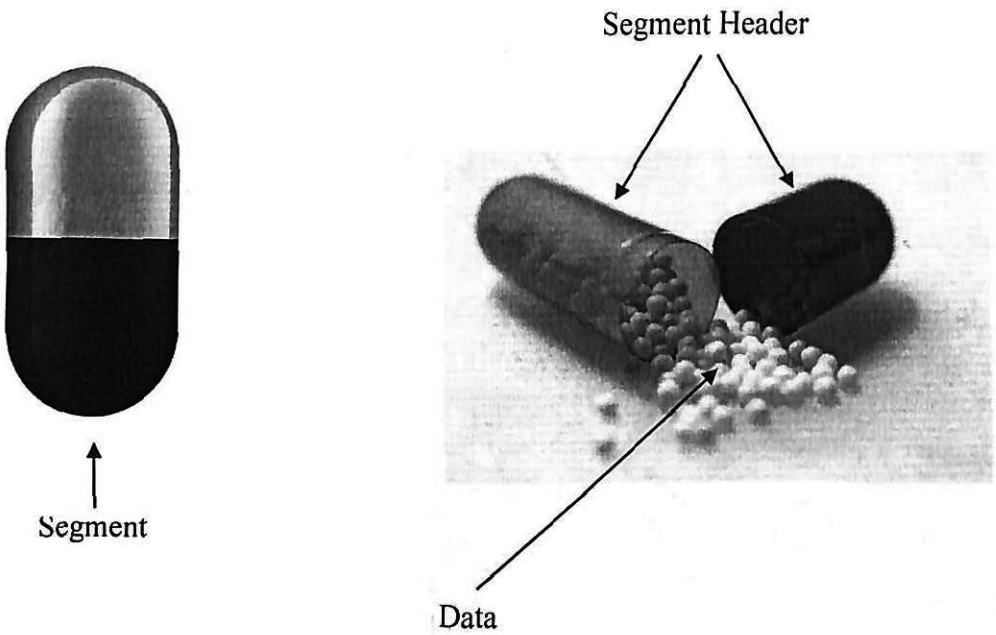


Figure Error! No text of specified style in document.**:24 Encapsulation**

Figure 0:25 show Example of Transport Layer encapsulation.
One more example of Encapsulation in Transport Layer:

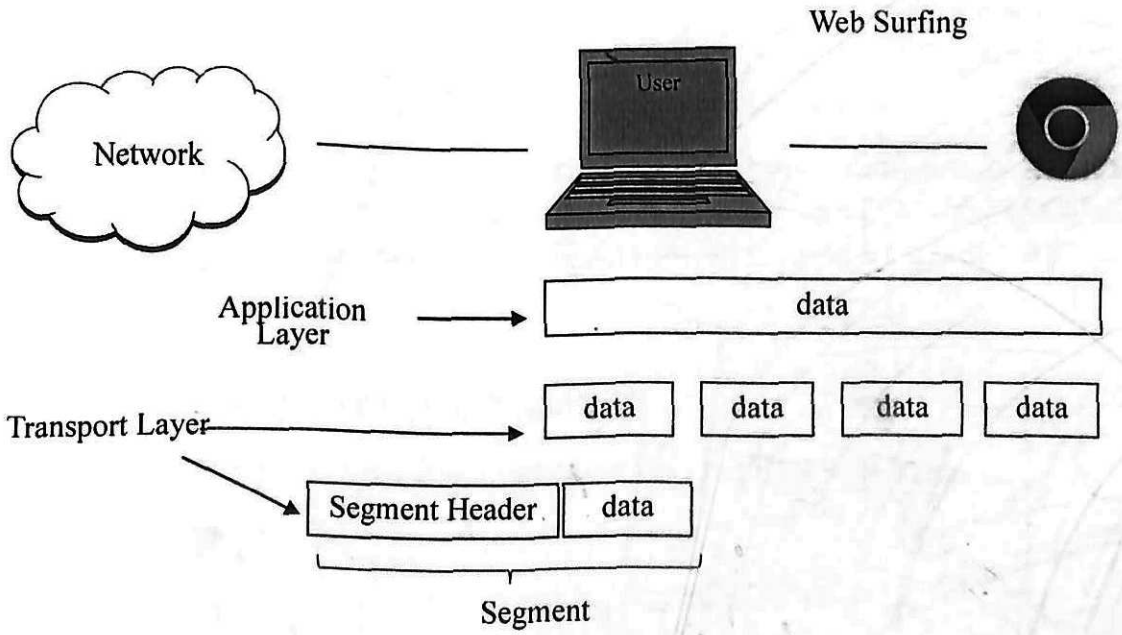


Figure Error! No text of specified style in document.**:25 Encapsulation of Transport Layer**

2.15 Lesson 15

Tracking Individual Conversations

Transport Layer provides Multi-Connection by using "Ports".
Any host may have multiple applications that are communicating across the network. Each of these applications will be communicating with one or more applications on remote hosts. It is the responsibility of the Transport layer to maintain the multiple communication streams between these applications.

Let us take a look at the graphical example to easily understand how Transport Layer makes that.

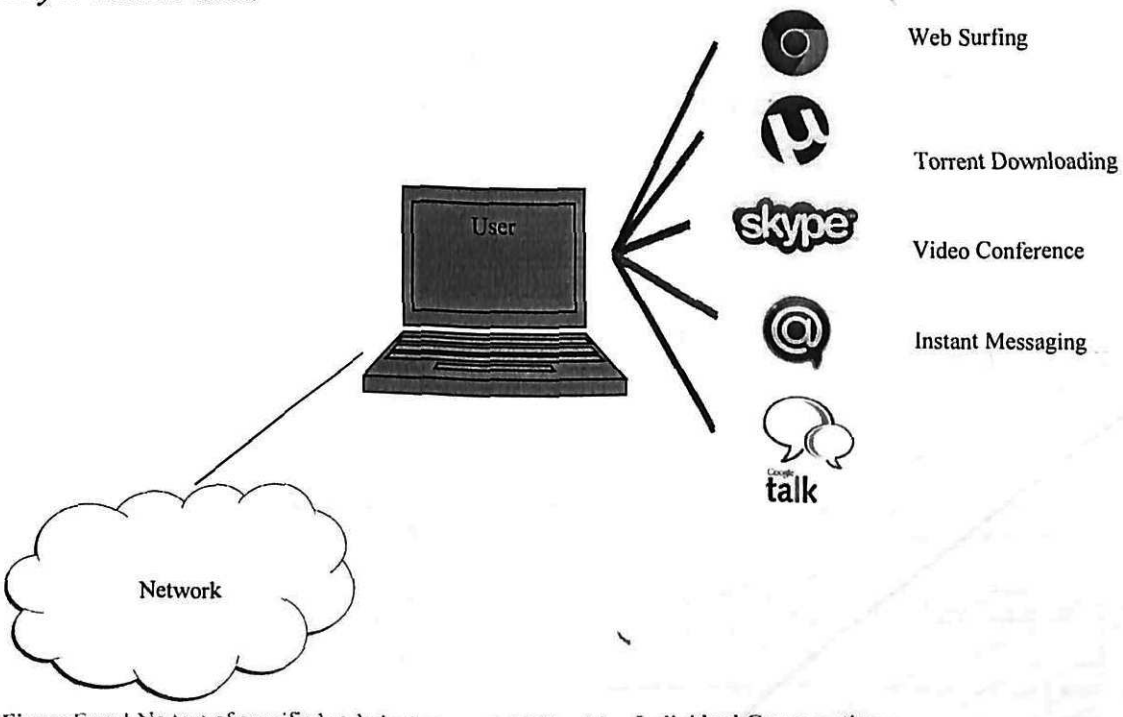


Figure Error! No text of specified style in document.**:26 Tracking Individual Conversations**

In this figure 0:26, you see different types of application which are making communication over one media to the networks, in this example they are separated by differently coloured lines, but in real life separation is done by using ports.

2.16 Lesson 16

Example of Reassembling Segments:

Figure 0:27 show how transport layer reassembles segments.

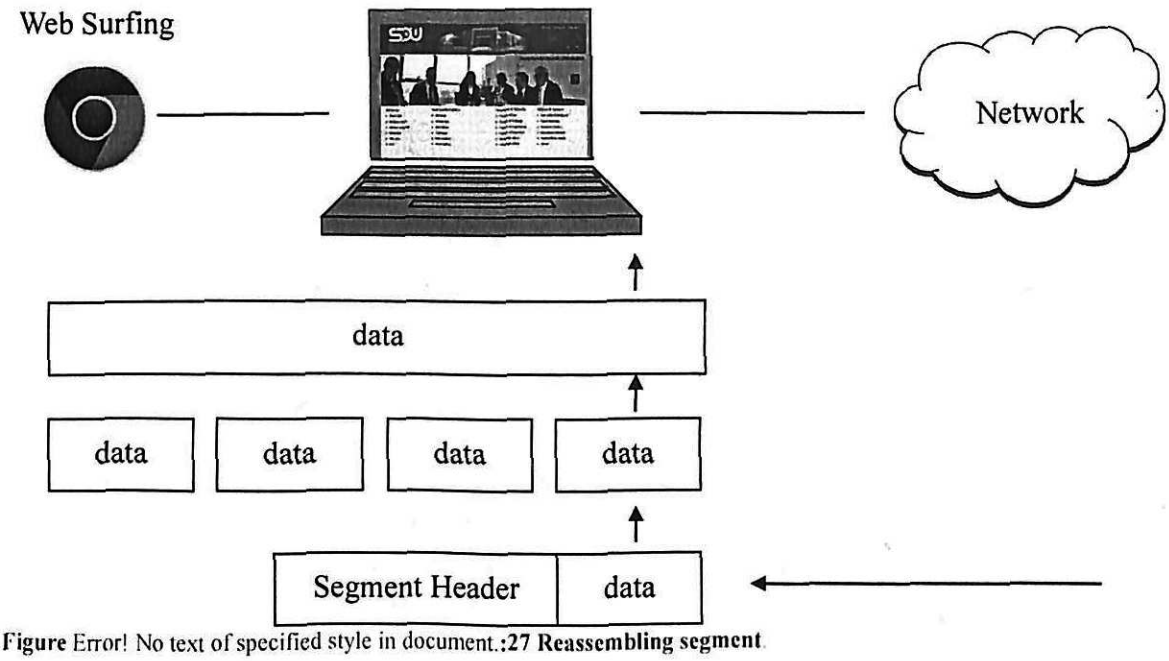


Figure Error! No text of specified style in document.**:27 Reassembling segment**

2.17 Lesson 17

Controlling the Conversations

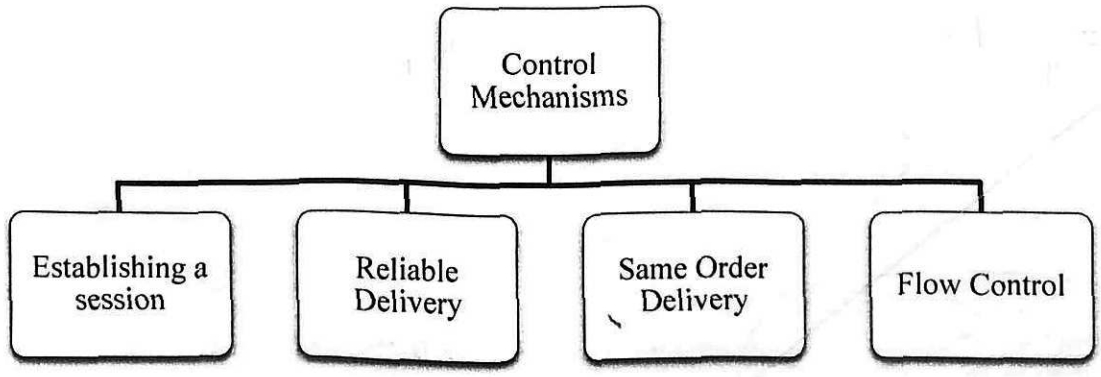


Figure Error! No text of specified style in document.**:28 Control Mechanisms**

Figure 0:28 show Control Mechanisms of Transport Layer.

Establishing a session

The Transport layer can provide this connection orientation by creating a sessions between the applications. These connections prepare the applications to communicate with each other before any data is transmitted. Within these sessions, the data for a communication between the two applications can be closely managed.

Reliable Delivery

For many reasons, it is possible for a piece of data to be corrupted, or lost completely, as it is transmitted over the network. The Transport layer can ensure that

all pieces reach their destination by having the source device to retransmit any data that is lost.

Same Order Delivery

Because networks may provide multiple routes that can have different transmission times, data can arrive in the wrong order. By numbering and sequencing the segments, the Transport layer can ensure that these segments are reassembled into the proper order.

Flow Control Mechanism

Network hosts have limited resources, such as memory or bandwidth. When Transport layer is aware that these resources are overtaxed, some protocols can request that the sending application reduce the rate of data flow. This is done at the Transport layer by regulating the amount of data the source transmits as a group. Flow control can prevent the loss of segments on the network and avoid the need for retransmission.

2.18 Lesson 18

Transport Layer Protocols

Computers use different types of Transport layers protocols for some reasons.

Question: What is the reason of using different Transport Layer Protocols?

To answer this question we have to list different types of Computer Networks Communications:

- Web Browsing
- File Sharing
- IP Telephony
- Video Streaming (Conference or online lessons)
- Working with e-mail

Question: For which of the above listed communications do we need reliable transportation and for which of them do we need to have high speed transportation?

Answer: Web browsing, File sharing and work with e-mail need to have reliable transportation. IP telephony and Video Streaming need to have high speed transportation.

Comparison of needs for Transport Layer Protocols

Figure 0:29 show needs for Transport Layer Protocols.

- **P Telephony**
- **Video Streaming**

- **SMTP/POP**
- **HTTP**

Required Protocol Properties
- Fast
- Low Overhead
- Doesn't require acknowledgements
- Doesn't resend lost data
- Delivers data as it arrives

7. Application
6. Presentation
5. Session
4. Transport
3. Network
2. Data - link
1. Physical

Required Protocol Properties
- Reliable
- Acknowledge data
- Resend lost data
- Delivers data in sent order

Figure Error! No text of specified style in document.**:29 Comparison of needs for Transport Layer Protocols**

Transport Layer Protocols

Figure 0:30 show Transport Layer Protocols.

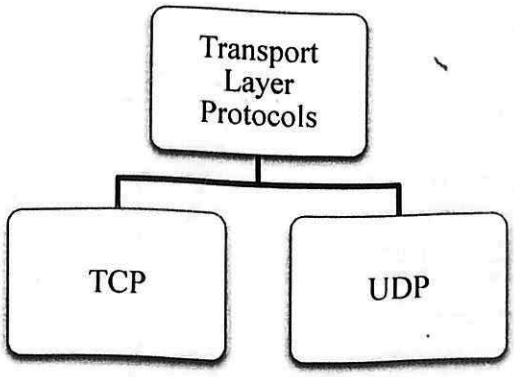


Figure Error! No text of specified style in document.**:30 Transport Layer Protocols**

TCP – Transmission Control Protocol

TCP is reliable protocol used in: Web browsing, E-mail and in File Transferring.

UDP – User Datagram Protocol

UDP is unreliable and fast protocol used in: Video Conference and IP Telephony.

2.19 Lesson 19

Identifying Conversations

To identify different conversations, Transport Layer uses Port Addresses. Figure 0:31 show how transport layer identify conversations.

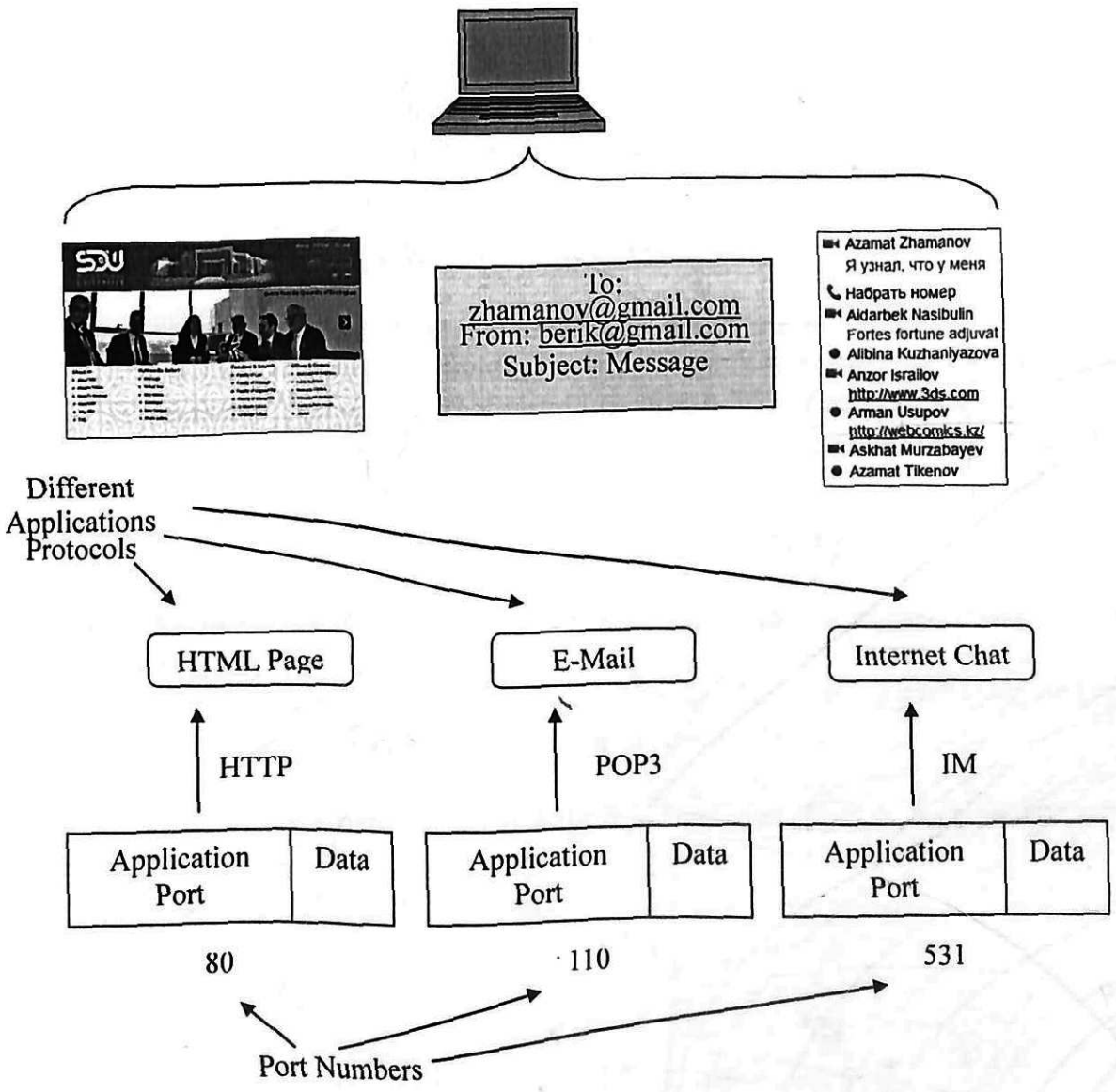


Figure Error! No text of specified style in document.**:31 Identifying Conversations**

2.20 Lesson 20

Port Addresses

Figure 0:32 show port address's hierarchy.

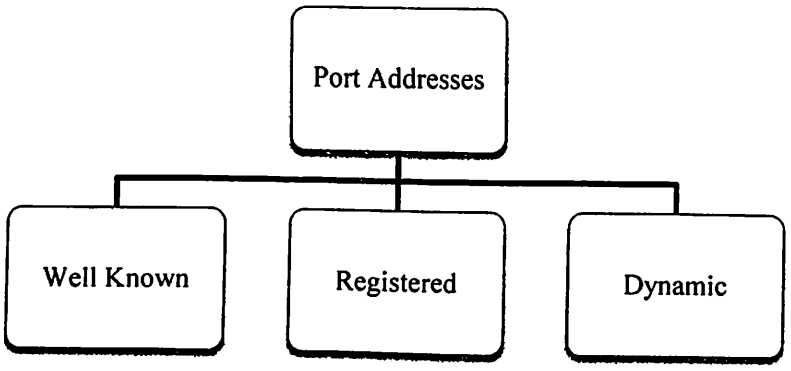


Figure Error! No text of specified style in document.:32 Port Address's hierarchy

Well Known Ports (Numbers 0 to 1023)

Are ports are served for services and applications.
They are commonly used for applications such as HTTP (web server) POP3/SMTP (e-mail server) and Telnet.

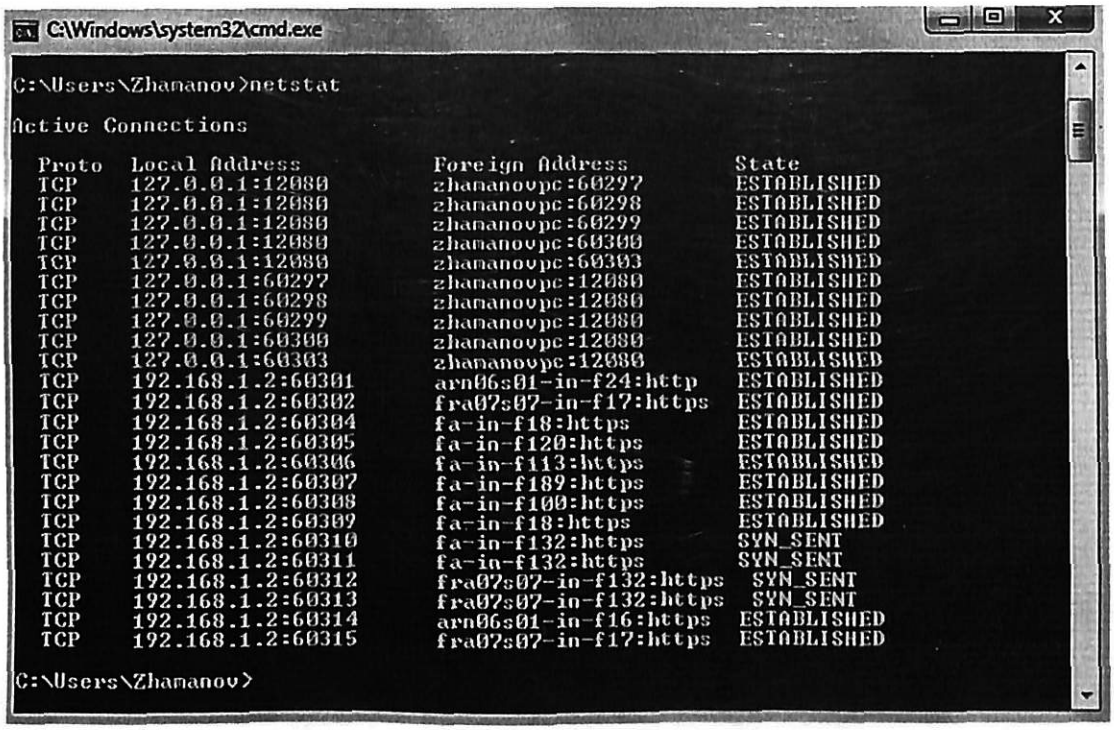
Registered Ports (Numbers 1024 to 49151)

Registered Ports are assigned to user processes or applications.
These processes are primarily individual applications that a user has chosen to install rather than common applications that would receive a Well Known Port.
When not used for a server resource, these ports may also be used dynamically selected by a client as its source port.

Dynamic or Private Ports (Numbers 49152 to 65535)

Also known as Ephemeral Ports, these are usually assigned dynamically to client applications when initiating a connection.
It is not very common for a client to connect to a service using a Dynamic or Private Port (although some peer-to-peer file sharing programs do).

NETSTAT is an important network utility that can be used to verify current connections
Example of Netstat command in cmd:



2.21 Lesson 21

TCP and UDP Handle Segmentation Differently

Figure 0:33 show difference between TCP and UDP segmentation.

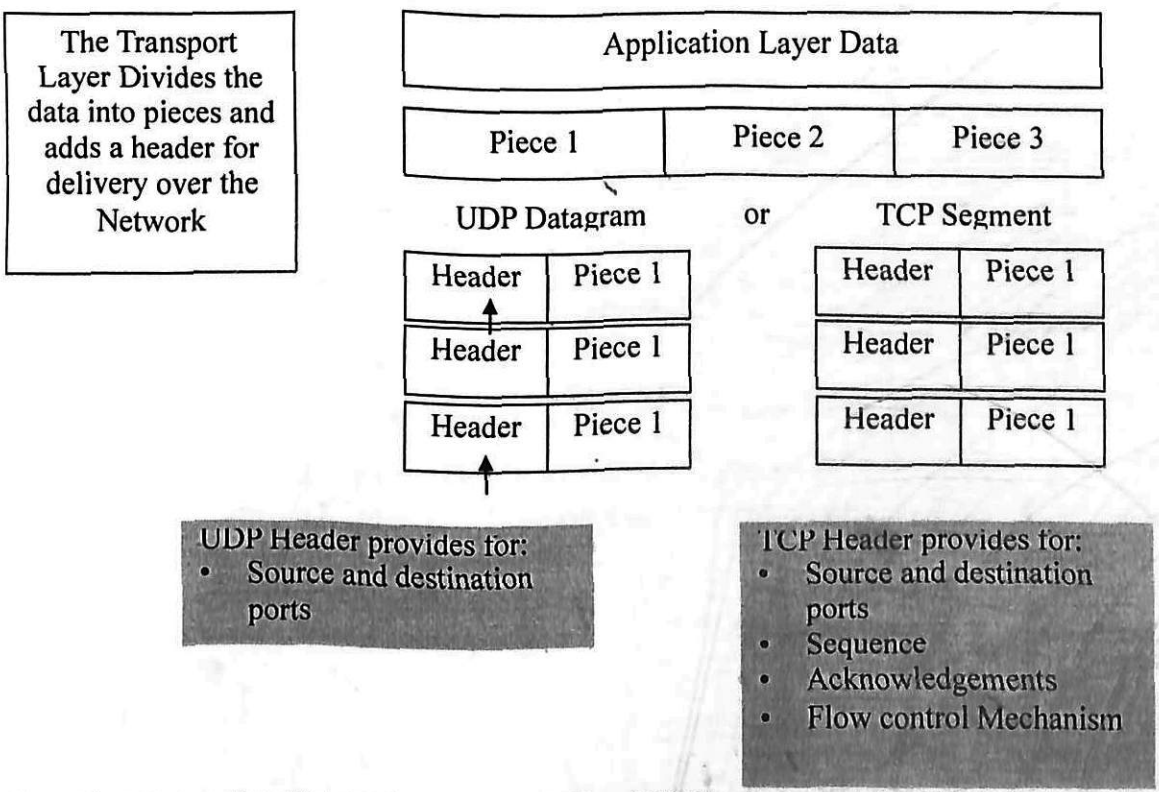


Figure Error! No text of specified style in document.**:33 TCP and UDP Handle Segmentation Differently**

TCP Header

Figure 0:34 show TCP header.

Bit (0) Bit(31)	Bit(15) Bit(16)
Source Port(16)	Destination Port(16)
Sequence Number (32)	
Acknowledgement Number (32)	
Header Length(4) Reserved(6) Code Bits(6)	Window(16)
Checksum(16)	Urgent(16)
Options(0 or 32 if any)	
Application Layer Data (Variable size)	

Figure Error! No text of specified style in document.:34 TCP Header

Source Port – Defines from which port data is transferred
Destination Port – Defines to which port data will be delivered
Sequence Number–Defines order of Segment
Acknowledgement Number – Defines next expected bit sequence
Header Length – Defines Header length in bytes
Reserved–Reserved
Code Bits–Used in session management and in the treatment of segments
Window – Window size defines number of bits before sending acknowledgement
Checksum – Used for error checking of Header and Data
Urgent – Used for defining that this Segment has to be sent urgently

UDP Header

Figure 0:35 show UDP Header.

Bit (0) Bit(31)	Bit(15) Bit(16)
Source Port(16)	Destination Port(16)
Length(16)	Checksum(16)
Application Layer Data (Variable size)	

Figure Error! No text of specified style in document.:35 UDP Header

Source Port – Defines from which port data is transferred
Destination Port – Defines to which port data will be delivered
Length – Defines length of Datagram
Checksum – Specifies check
Application Layer Data - Data

2.22 Lesson 22

TCP in Process

In this example Client wants to open home page of "www.baribar.kz" web server. For this purpose client has to send segment to port number 80, because 80s port is used by HTTP protocol only. Now we know the destination port number and we have to learn what will be source port number. Source port number is chosen randomly by computer from range of "Dynamic ports" or can also be chosen from "Registered port" number if they are not used by registered application. Figure 0:36 show port role in communication.

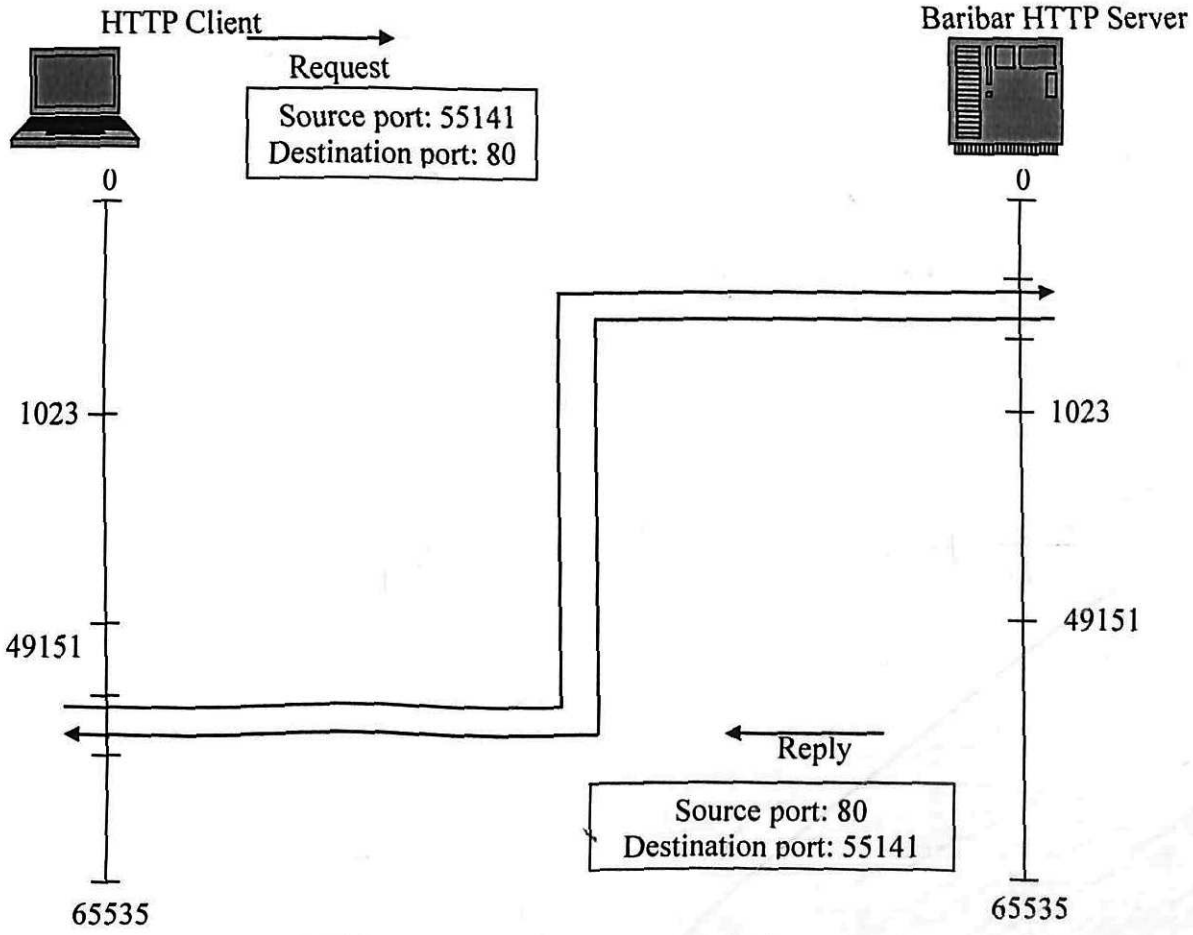


Figure Error! No text of specified style in document.:**36 Port role in communication**

One more example of port usage:

In this example two clients are making request to one server simultaneously. Figure 0:37 show two clients which are connecting to one HTTP server.

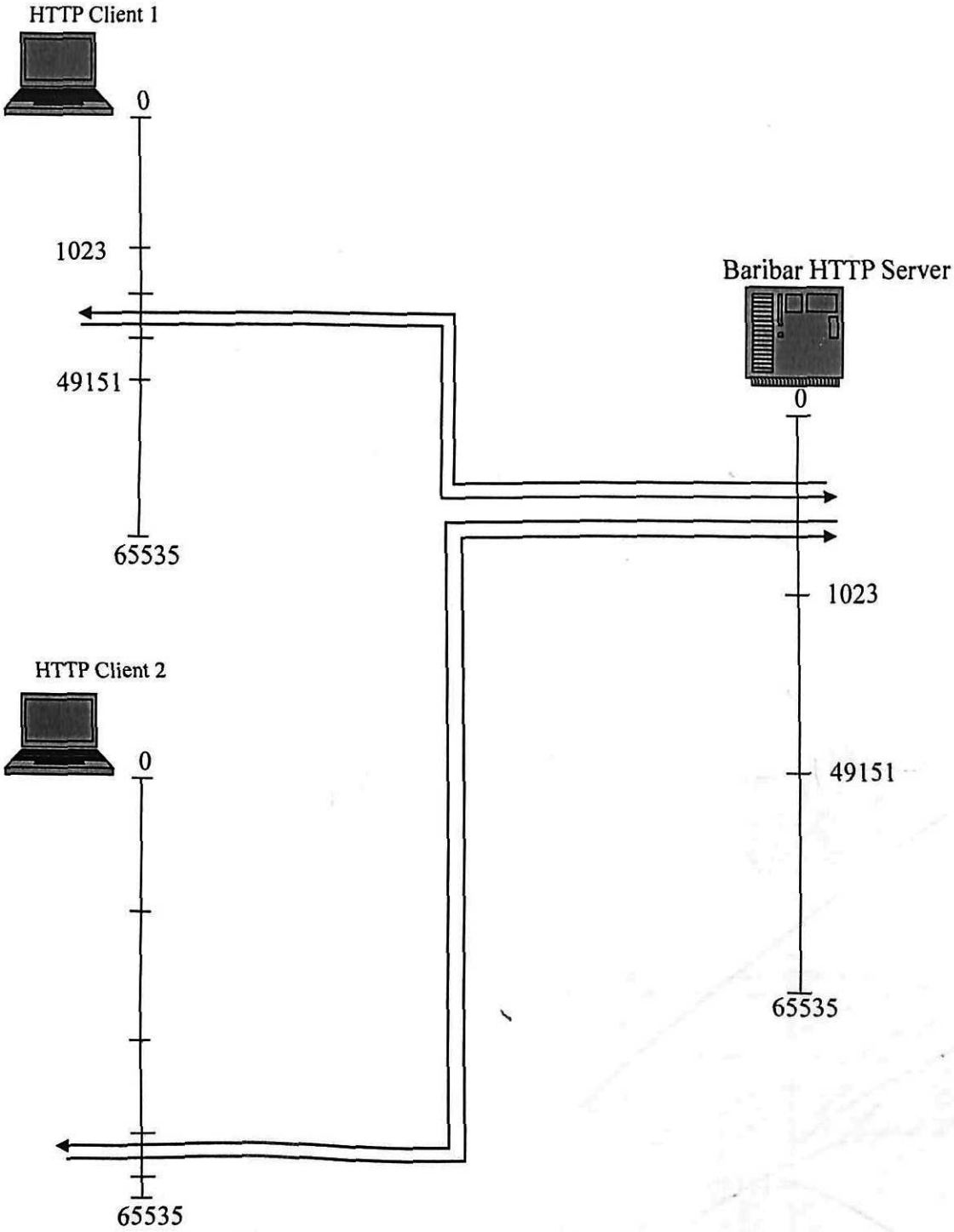


Figure Error! No text of specified style in document.**:37 Two client one server**

Example of communication from one client to many servers:
Figure 0:38 show how one client can make connection to two servers.

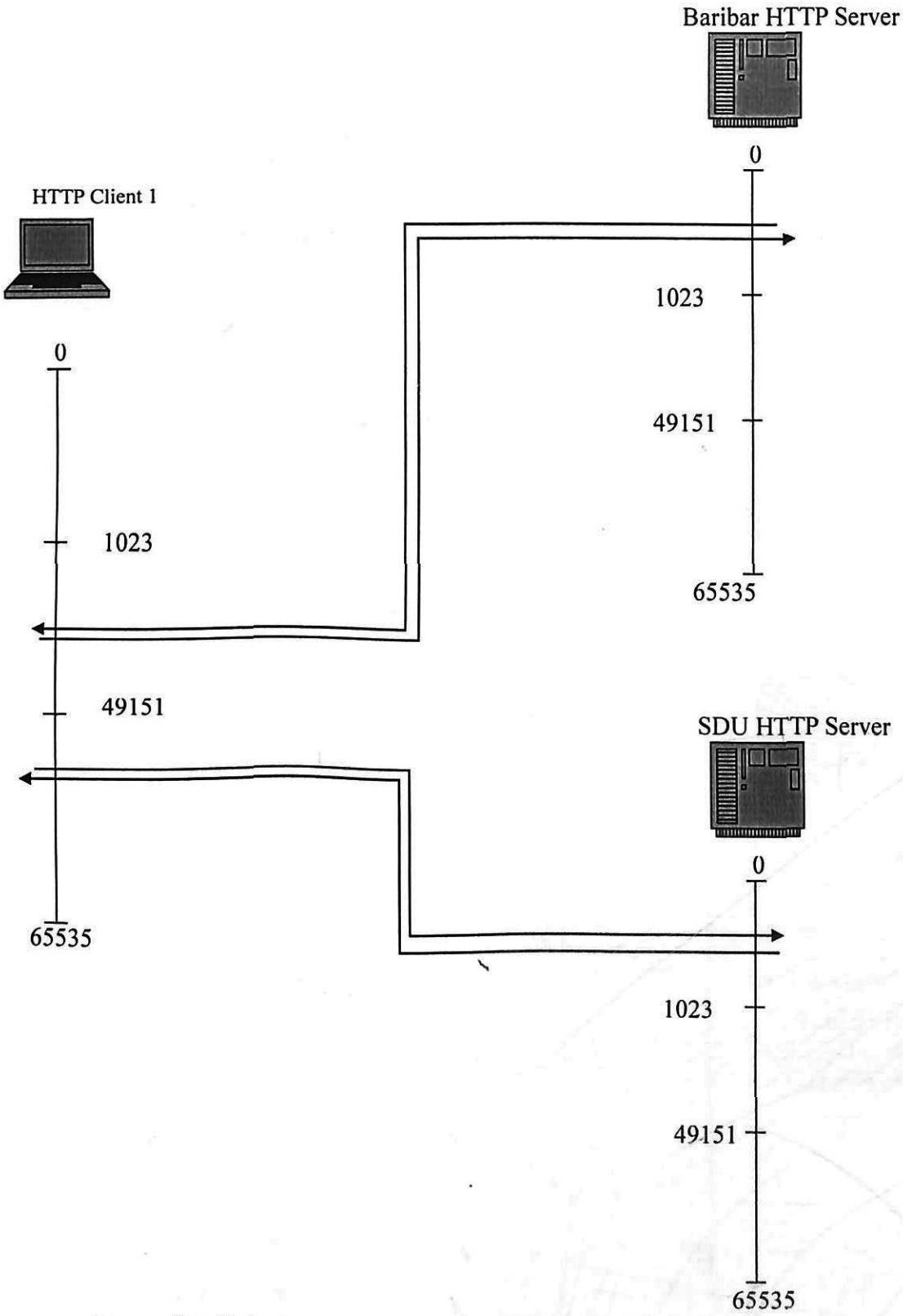


Figure Error! No text of specified style in document.**:38 One client two servers**

2.23 Lesson 23

TCP Connection Establishment and Termination

When we want to speak with friend, firstly we have to make establishment of our conversation by using handshake

TCP like people also makes establishment of connection by using handshake, but in three ways.

Three way handshake

Figure 0:39 show three way handshakes.

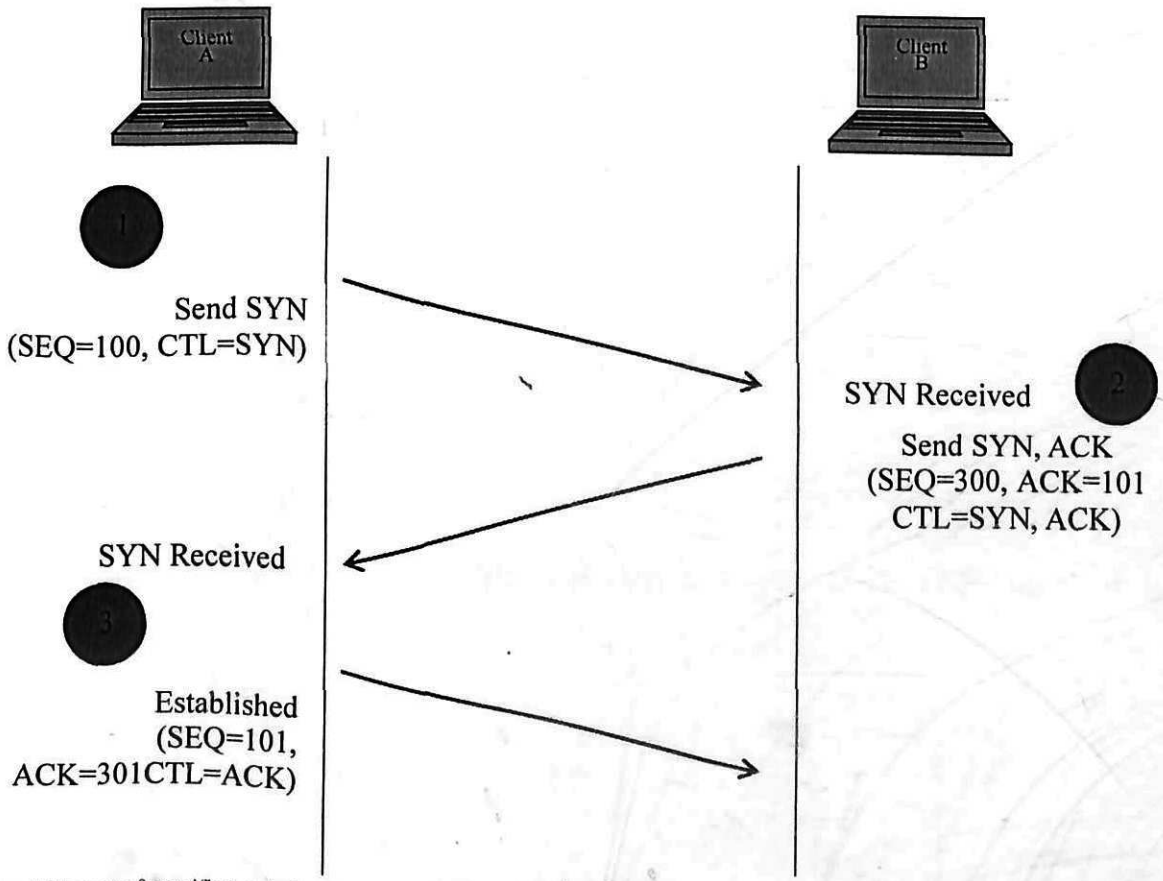


Figure Error! No text of specified style in document.**:39 Three way handshake**

When people want to finish conversation they usually say "good-bye"

TCP like People also makes signal when it finishes a dialog

Session Termination (4 steps)

Figure 0:40 show Session Termination.

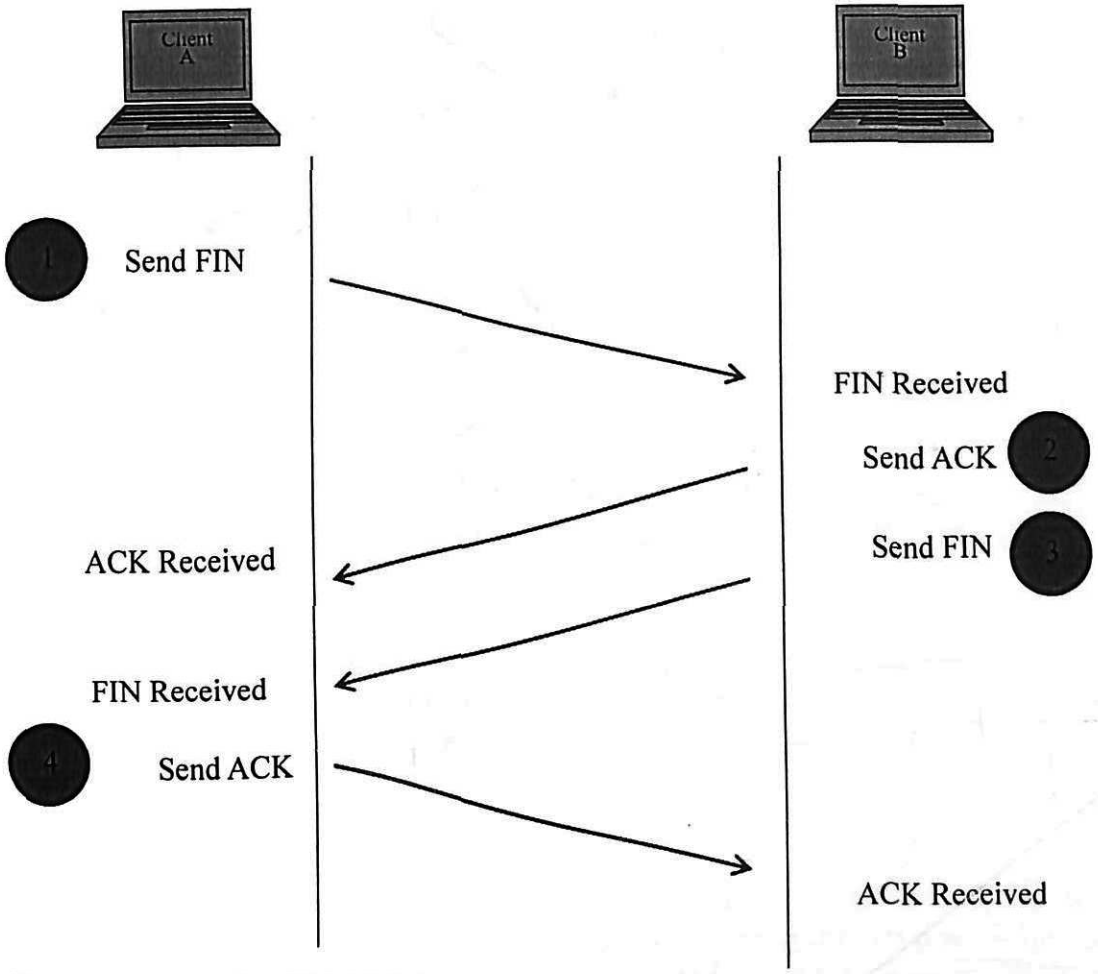


Figure Error! No text of specified style in document.**:40 Session Termination**

2.24 Lesson 24

Re-ordering segments

Different segments may take different routes. Figure 0:41 show re-ordering segments.

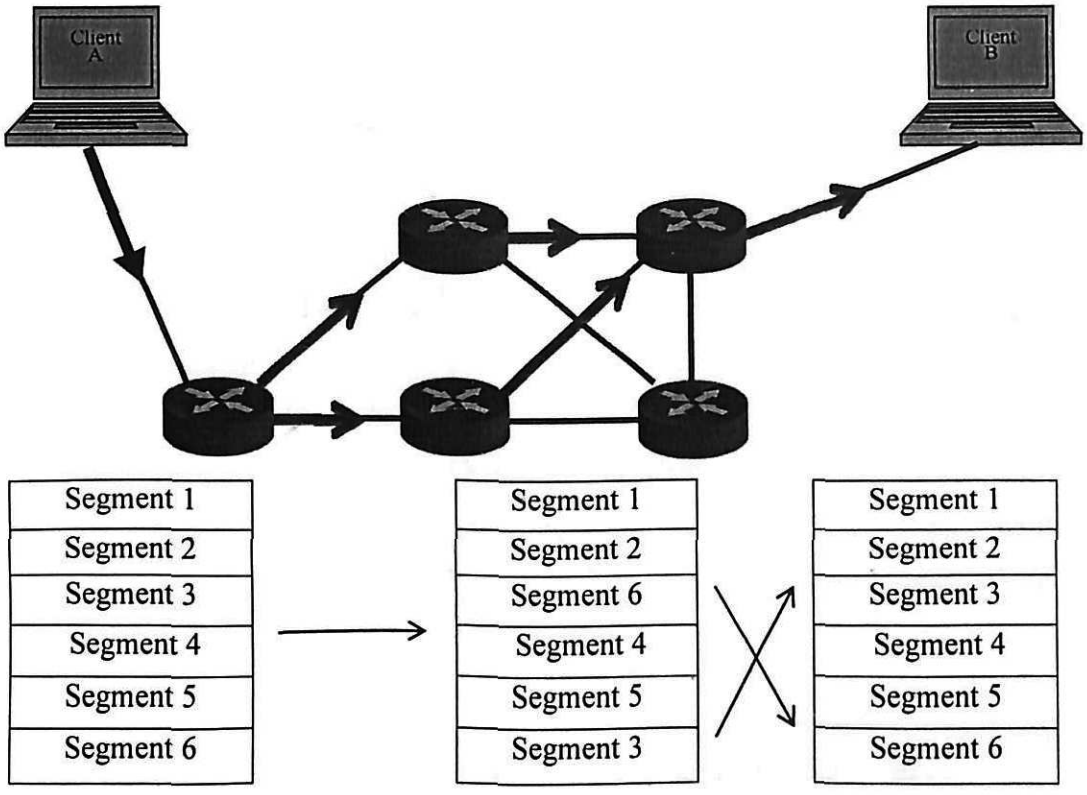


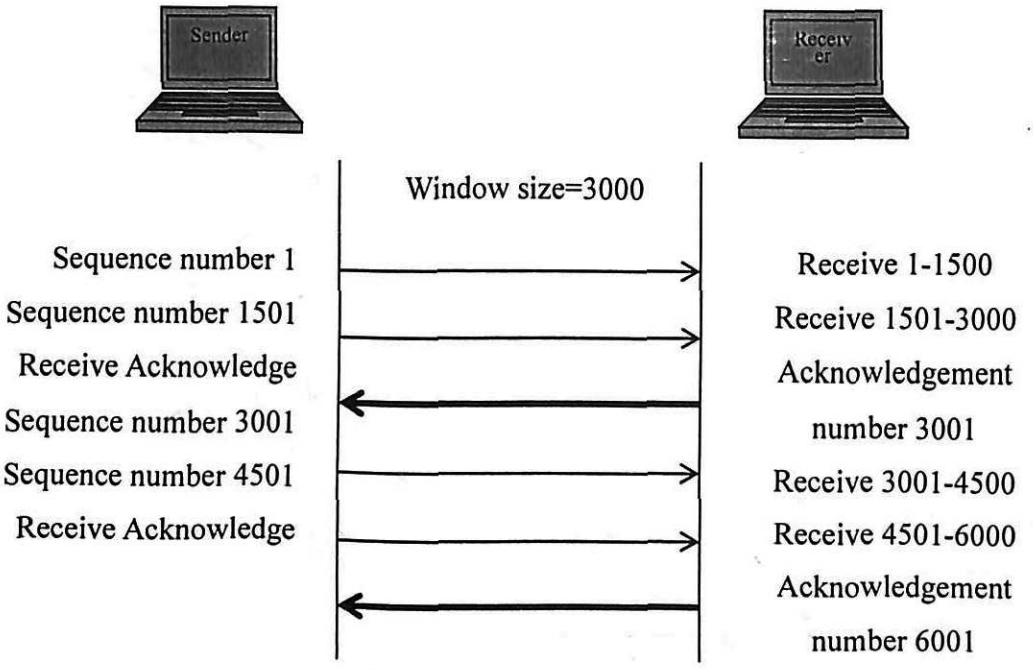
Figure Error! No text of specified style in document.:**41 Re-ordering segments**

Flow Control Mechanism

Flow control assists the reliability of TCP transmission by adjusting the effective rate of data flow between the two services in the session. When the source is informed that the specified amount of data in the segments is received, it can continue to send more data for this session.

This Window Size field in the TCP header specifies the amount of data that can be transmitted before an acknowledgement must be received. The initial window size is determined during the session startup via the three-way handshake.

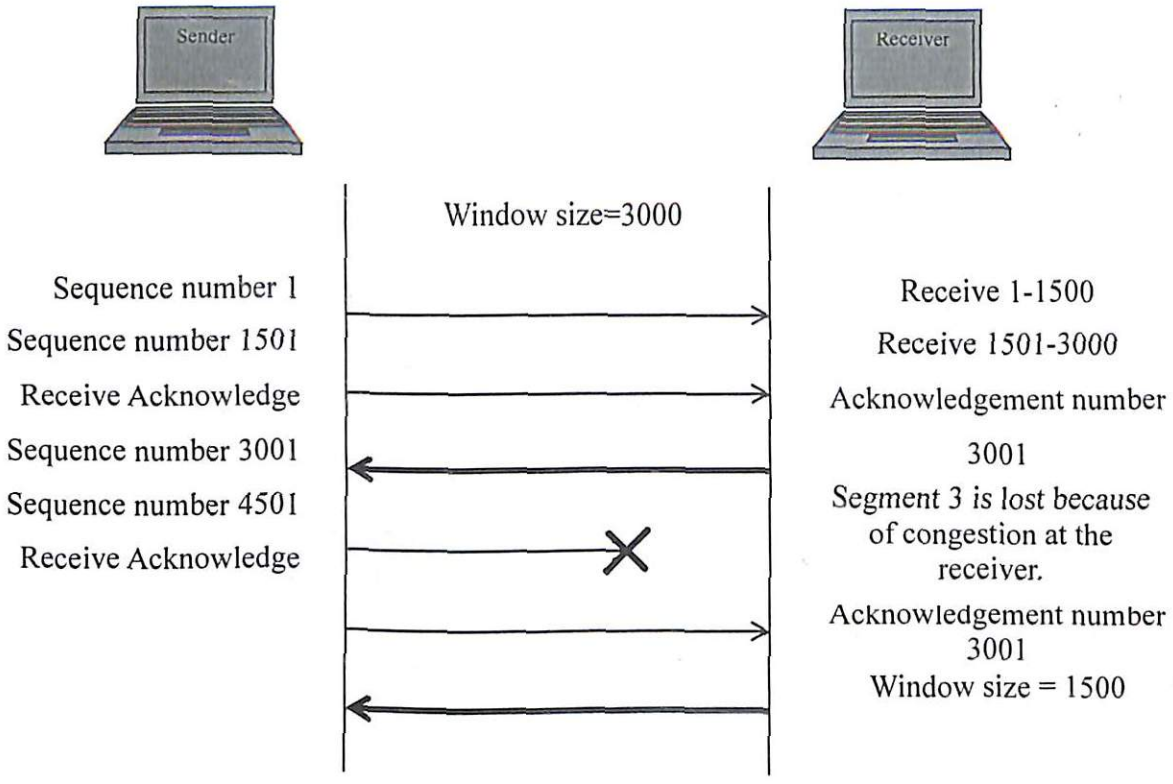
Example of Flow Control Mechanism:
Figure 0:42 show flow control mechanism.



The **windows size** determines the number of bytes sent before an acknowledgement is expected
The **acknowledgement number** is the number of the next expected byte.

Figure Error! No text of specified style in document.:**42 Window Size**

Example of Flow Control Mechanism with Problem:
Figure 0:43 show flow mechanism with problem.



If segments are lost because of congestion, the receiver will acknowledge the last received sequential segment and reply with a reduced window size

Figure Error! No text of specified style in document.:**43 Flow control with problem**

2.25 Lesson 25

Introduction to OSI Network Layer

Transport Layer Provides connection between applications.
Network Layer Provides connection between Networks, by using IP addresses.

PDU of Network Layer is called Packet.

Four Basic Processes of Network Layer

Figure 0:44 show Network Layer Processes

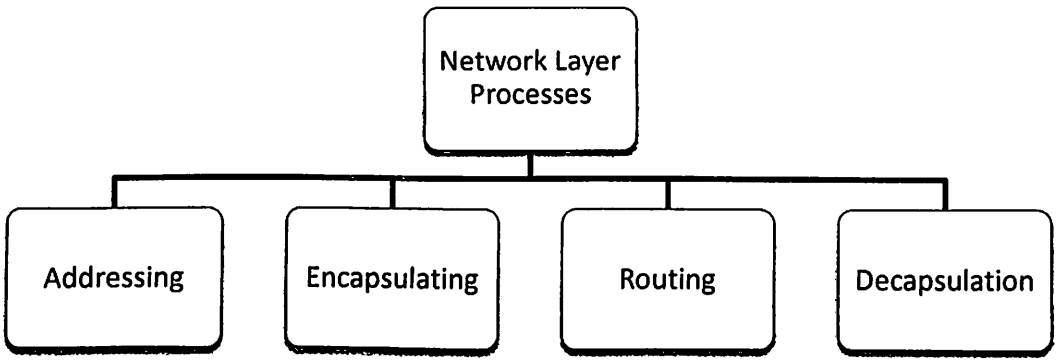


Figure Error! No text of specified style in document.:44 **Network Layer Processes**

Addressing

First, the Network layer must provide a mechanism for addressing these end devices. If individual pieces of data are to be directed to an end device, that device must have a unique address. In an IPv4 network, when this address is added to a device, the device is then referred to as a host.

Encapsulation

Encapsulation is a process of preparing data before being transmitted to the media.

Figure 0:45 show encapsulation at network layer.

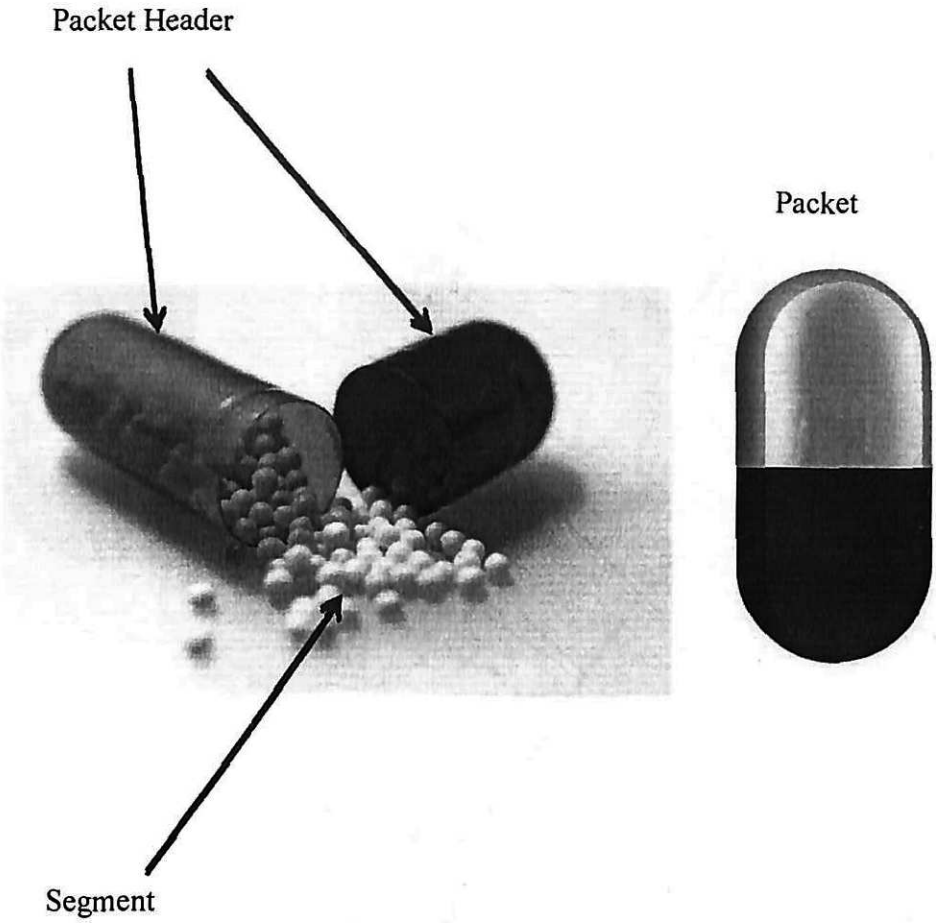


Figure Error! No text of specified style in document.**:45 Encapsulation**

After the Network layer completes its encapsulation process, the packet is sent down to the Data Link layer to be prepared for transportation over the media.

Routing

Giving path for destination network

Decapsulation

Preparing data for delivery to application layer
Figure 0:46 show Decapsulation at network layer.

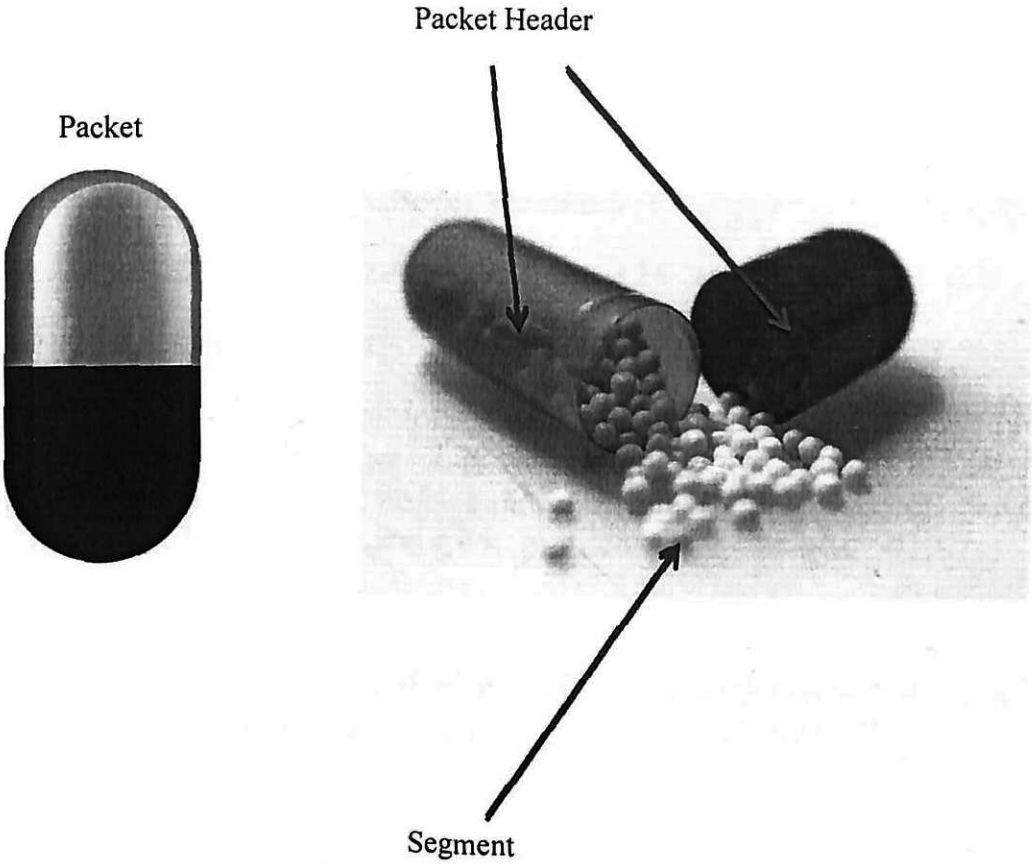


Figure Error! No text of specified style in document.:**46 Decapsulation**

When data is received by network layer, network layer will delete unnecessary parts of packet called packet header and after what will deliver segment to the transport layer.

2.26 Lesson 26

Network Layer Protocols

Figure 0:47 show Network Layer Protocols.

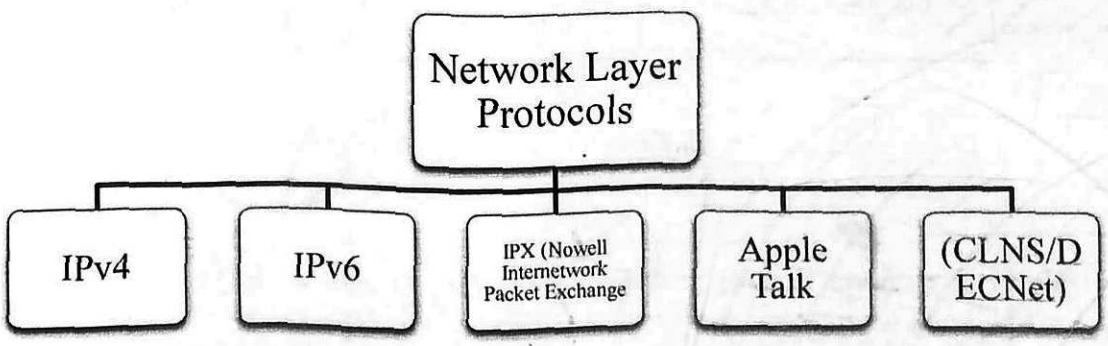


Figure Error! No text of specified style in document.:**47 Network Layer Protocols**

IPv4 – Internet Protocol Version 4

Is one of the famous Network Layer Protocols in modern computer network structure.

IPv6 – Internet Protocol Version 6

Soon is going to be one of the famous Network Layer Protocols.

IPX - Internetwork Packet Exchange

The IPX/SPXM protocol stack is supported by Novell's NetWare network operating system. Because of Netware's popularity through the late 1980s into the middle 1990s, IPX became a popular internetworking protocol. Novell derived IPX from Xerox Network Systems' IDP protocol.

Apple Talk

Apple Talk is a proprietary suite of protocols developed by Apple Inc.
In this chapter we will describe in details IPv4 and review IPv6

2.27 Lesson 27

IPv4 Four Basic Characteristics

Figure 0:48 show IPv4 Functionality

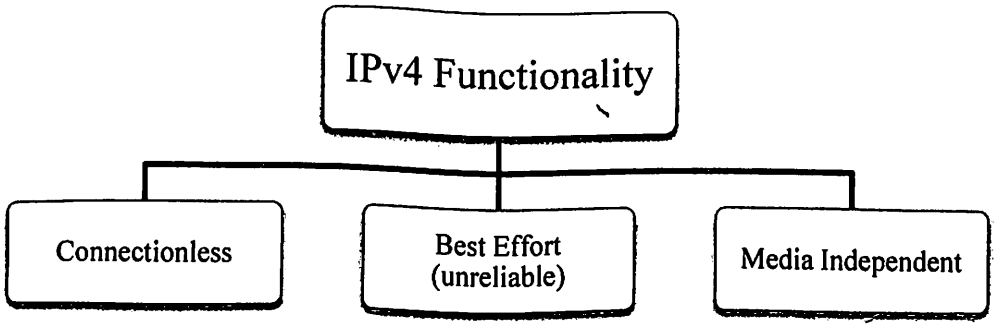


Figure Error! No text of specified style in document.:**48 IPv4 Functionality**

Connectionless

Connectionless means that IPv4 protocol doesn't create session before before packaging.

Example of Post office services:

Figure 0:49 show connectionless characteristic of Network Protocols.

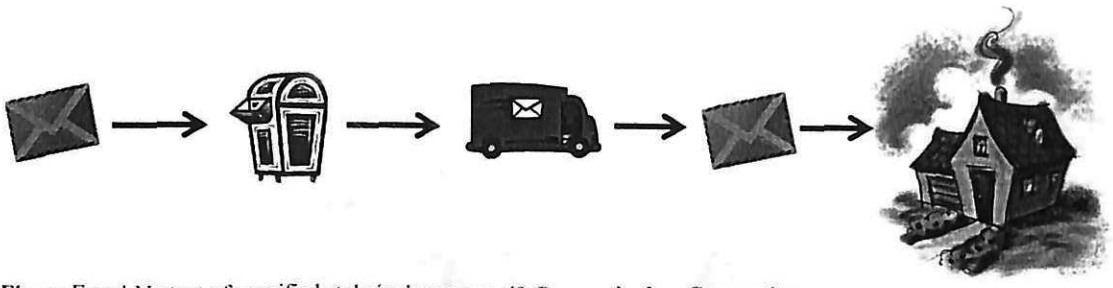


Figure Error! No text of specified style in document.**:49 Connectionless Connection**

When we send message to someone, we are not sure, that at moment when postman delivers the message, the receiver will be at home.
Example of connectionless in computer networks:
Figure 0:50 show Connectionless Connection.

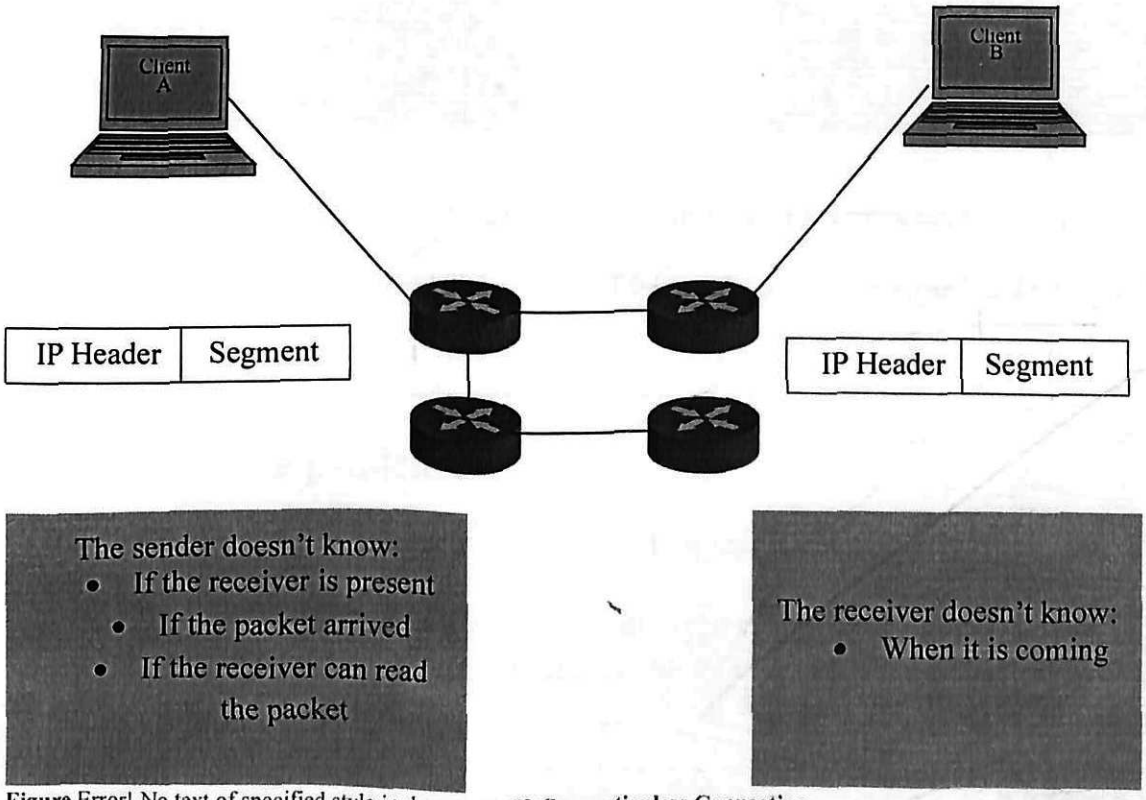
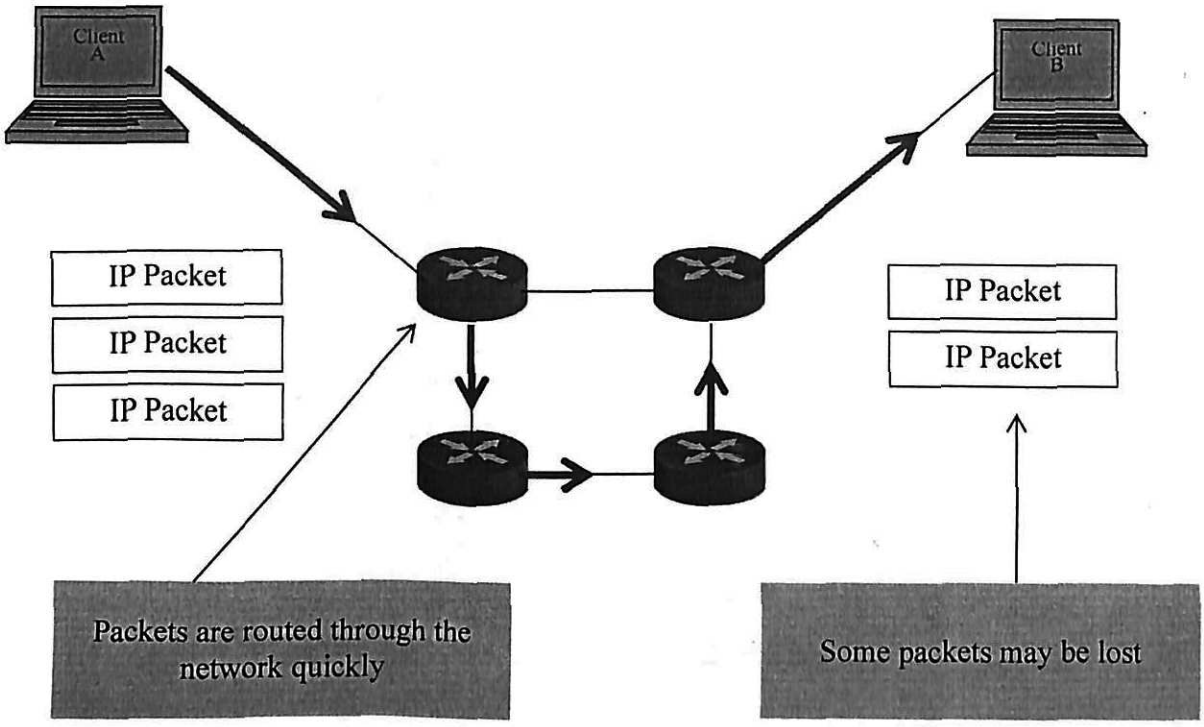


Figure Error! No text of specified style in document.**:50 Connectionless Connection**

Best Effort

In other words ***Unreliable***

Best effort example in computer networks:
Figure 0:51 show how packages can be lost.



As an unreliable Network Layer protocol, IP doesn't warrantee that all sent packets will be received.
Other protocols manage the process of tracking packets and ensuring their delivery.

Figure Error! No text of specified style in document.**:51 Package lost**

Media Independence

In different types of media, IP Packet doesn't change structure, but data-link frame does.

Example of IP Packet in different media types:

Figure 0:52 show Media Independence characteristics of Network Layer Protocols.

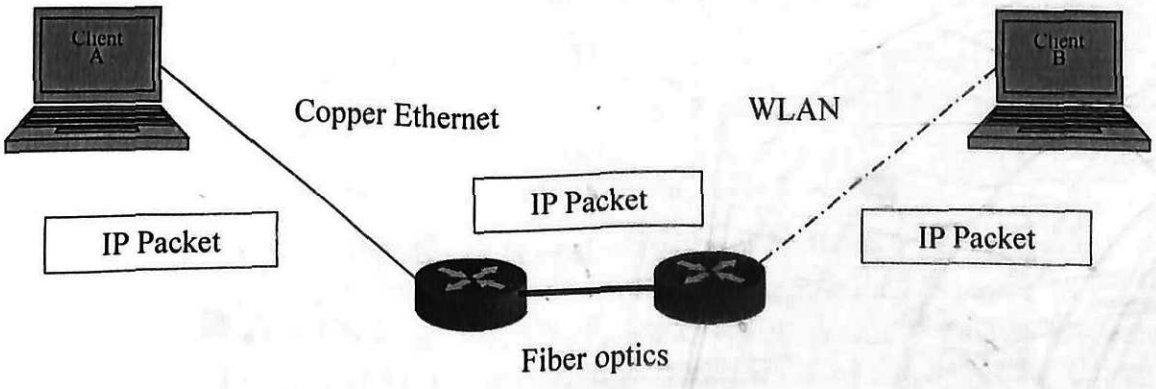


Figure Error! No text of specified style in document.**:52 Media Independence**

Different types of media have different maximum amount of bytes for single packet that can be transferred through that media. Amount of maximum bytes for single packet is called **Maximum Transmission Unit – MTU.**

MTU Table for popular media types:
Figure 0:53 show MTU Values

Media type	MTU
802.3	1492 bytes
802.11	2272 bytes
802.5 Token ring	4464 bytes
FDDI	4500 bytes

Figure Error! No text of specified style in document.**:53 MTU Values**

If a packet switches between different medias with different MTU (from higher to lower), packet must be splitted into **Fragments.**
Process of splitting packets is called **Fragmentation.**
Example of fragmentation process:
Figure 0:54 show fragmentation

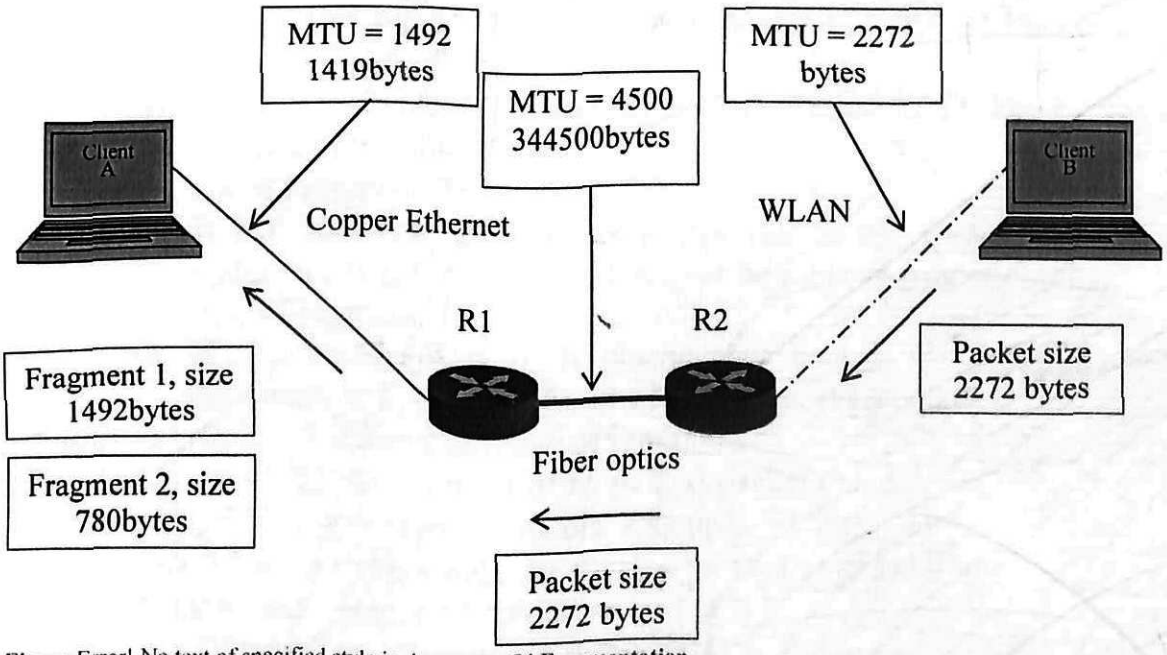


Figure Error! No text of specified style in document.**:54 Fragmentation**

In this example, client B sends packet to client A. Router R2 receives packet and resends it through fiber optics media without fragmentation, because MTU of fiber optics is bigger than MTU of WLAN. R1 receives packet and makes fragmentation, because MTU of Copper Ethernet is smaller than MTU of Fiber optics. Client A will receive two fragments and will store them in cash memory, after what client A will combine two fragments into one packet.

2.28 Lesson 28

Packet Header in Details

Figure 0:55 show fragment structure.

Byte 1		Byte 2	Byte 3		Byte 4
Ver.	IHL	Type of Service	Packet Length		
Identification			Flag	Fragment Offset	
Time to Live		Protocol	Header Checksum		
Source IP Address					
Destination IP Address					
Options					Padding
Segment (Data)					

Figure Error! No text of specified style in document.:55 Fragment Structure

Ver.- Defines Version of Network Layer Protocol
IHL – Defines size of Packet Header, needed because packet size can be changed
Type of Service – Specifies Priority of Packet, used for QoS
Packet Length – Defines Packet Header + Data Length. Minimum size is 20 bytes = 20 bytes of Packet Header + 0 Bytes of Data. Maximum size of Packet is 65,535 bytes.
Identification – Uniquely identifies fragments of an original IP Packet
Flag – Flag consists of two sub-flags:

1. **MF** – More Fragment: 1bit
    a. If MF statement is 0, it means that this is last fragment of packet. If statement is 1, it means that there is one more fragment coming.
2. **DF** – Don't Fragment: 1bit
    a. If DF statement is 0, it means that packet can be fragmented. If statement is 1, it means fragment can't be fragmented

Fragment Offset – Sequence number of Fragment
Time to Live – Maximum Number of Hops that packet can do
Protocol – Defines upper layer protocols. Example: TCP or UDP
Header Checksum – Responsible for check header state at each hop
Source IP Address – Sender's IP Address
Destination IP Address – Receiver's IP Address
Options – Some options if exist

Example of Packet Header:
Figure 0:56 show Fragmented Packet Header.

Byte 1		Byte 2	Byte 3	Byte 4
Ver=4	IHL=5	Type of Service	Packet Length = 472	
Identification=111			Flag=0	Fragment Offset=0
Time to Live=123		Protocol=6	Header Checksum	
192.168.1.1				
10.20.105.8				
Options				
Data				
Data				

Figure Error! No text of specified style in document.**:56 Fragmented Packet Header**

2.29 Lesson 29

Dividing Network into Sub-networks

Question: Why do we need to divide networks into sub-networks?
Answer: Large networks are difficult to Manage, Small networks are easy to Manage.

Large Network

Figure 0:57 show large network.

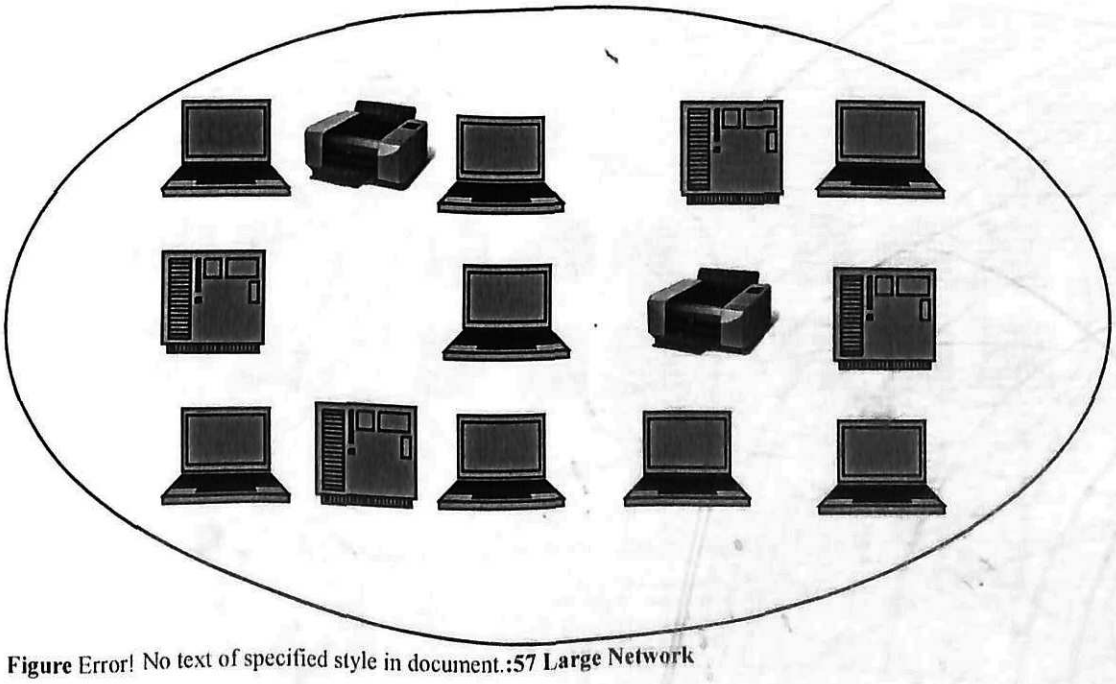


Figure Error! No text of specified style in document.**:57 Large Network**

Network Division Factors

Figure 0:58show Network Division Factors.

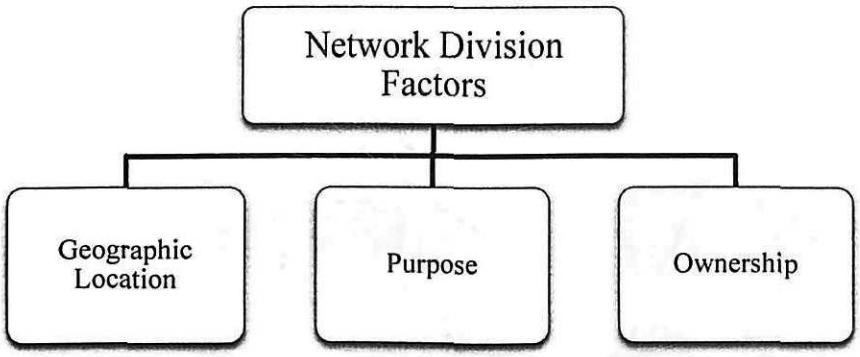


Figure Error! No text of specified style in document.**:58 Network Division Factors**

Division by Geographical Location

Figure 0:59 show division by geographical location.

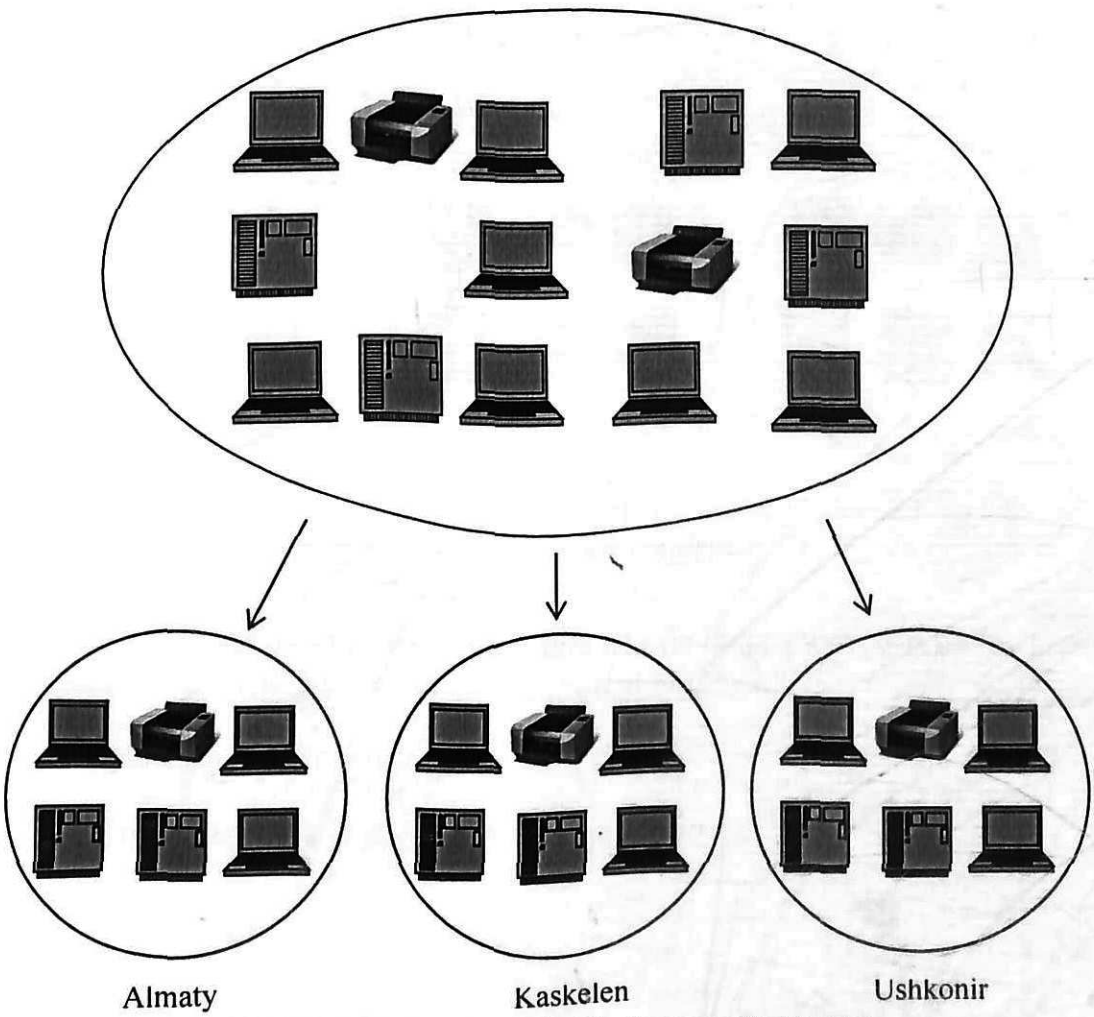


Figure Error! No text of specified style in document.**:59 Division by geographical location**

Division by Purpose

Figure 0:60 show division by purpose.

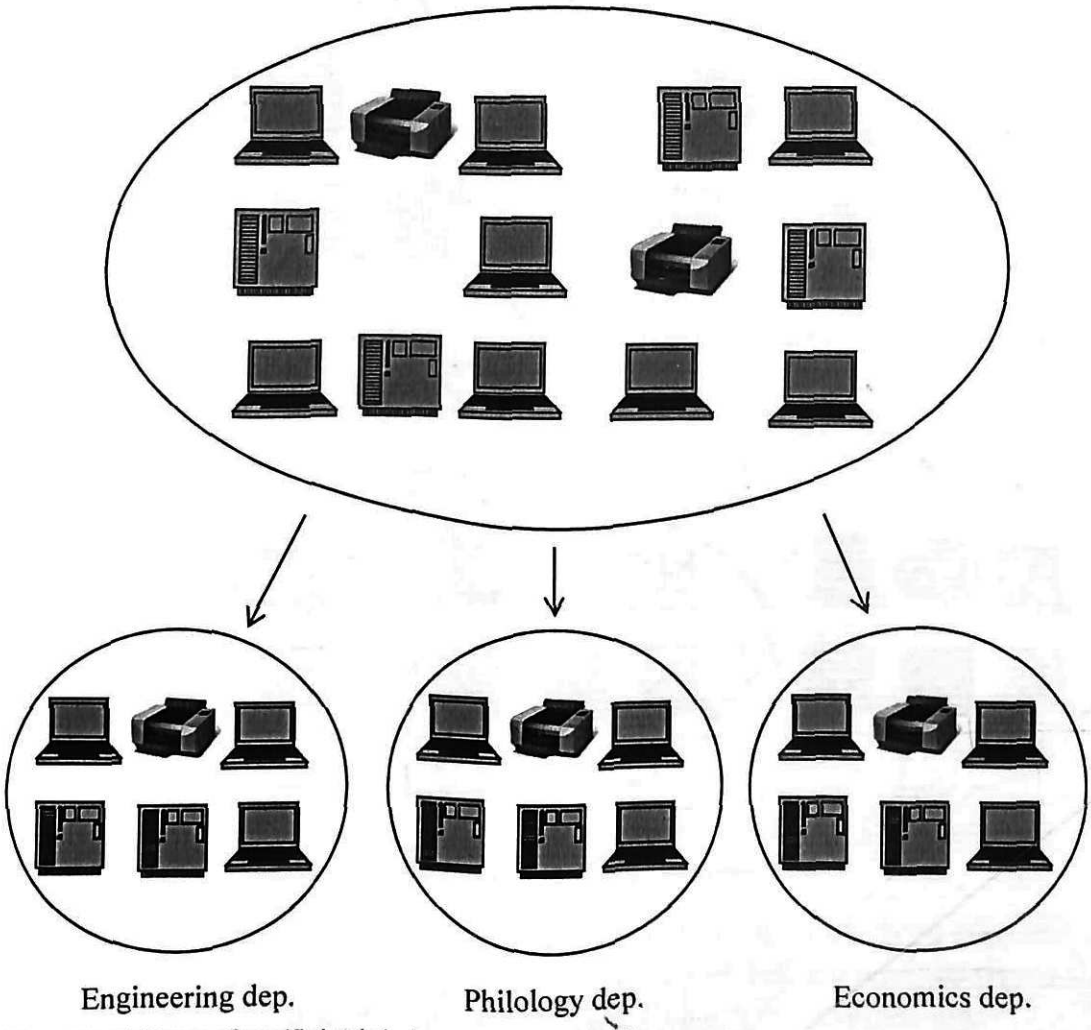


Figure Error! No text of specified style in document.**:60 Division by purpose**

In division by purpose, computers of one department can be located in different places but they will be placed in one logical network.

Division by Ownership

Figure 0:61 show division by ownership.

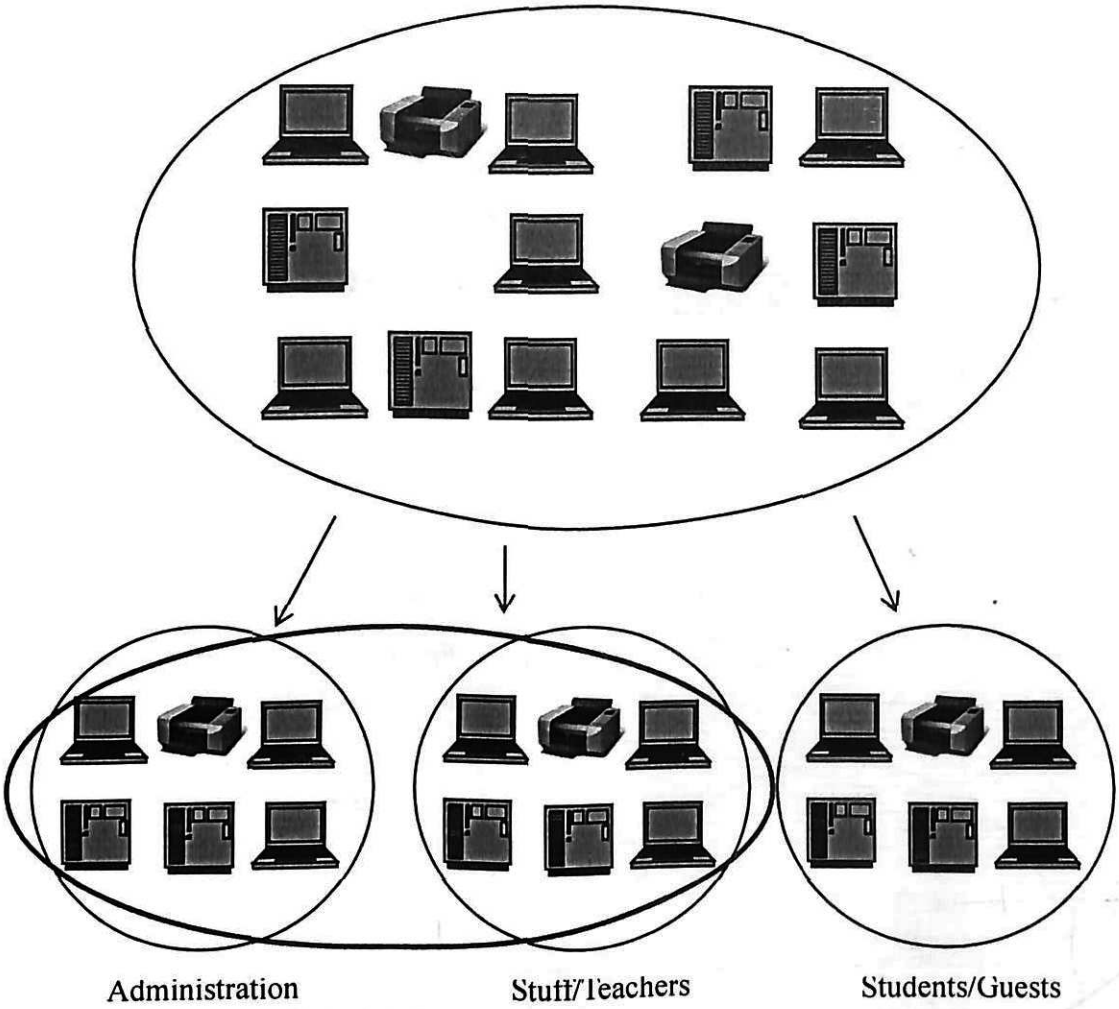


Figure Error! No text of specified style in document.**:61 Division by ownership**

Division by ownership makes difference in rights between sub-networks. In this example Administration and Stuff/Teachers subdivisions have rights for unlimited internet, but Students/Guests subdivision has limitations.

2.30 Lesson 30

Optimization of Network

Optimization of network - is changing structure of network topology to improve speed of connection.

Example of not optimized network:

Figure 0:62 show non optimized network.

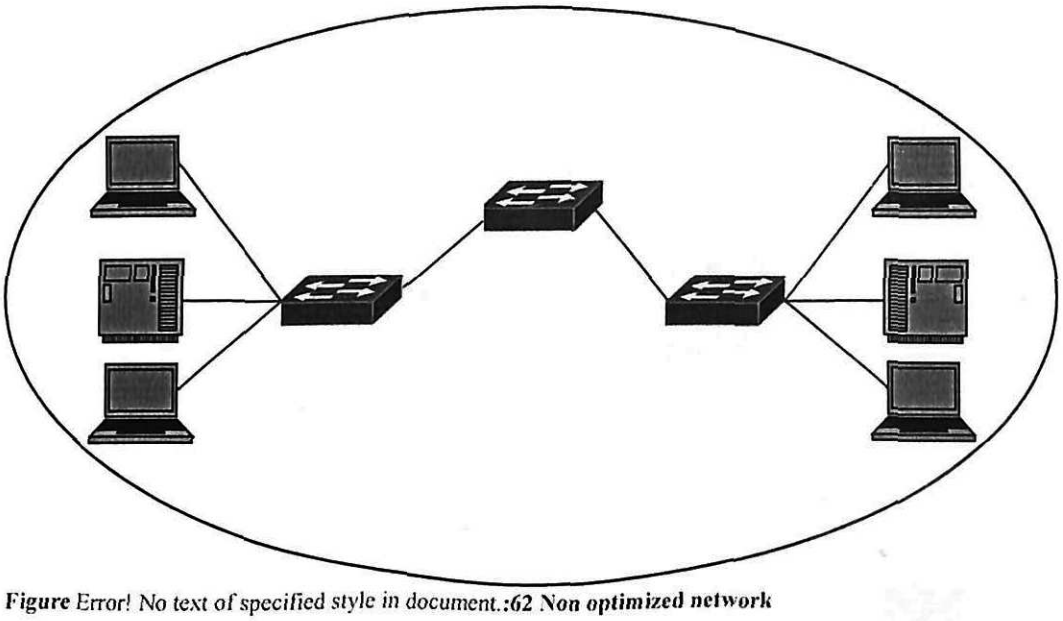


Figure Error! No text of specified style in document.**:62 Non optimized network**

Example of optimized network:
Figure 0:63 show optimized network.

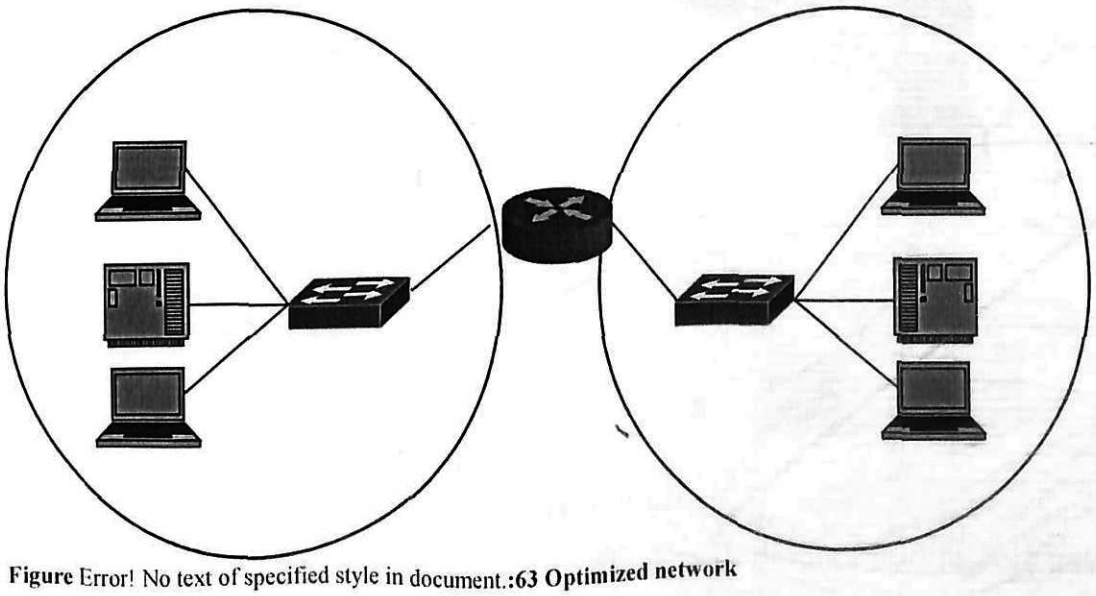


Figure Error! No text of specified style in document.**:63 Optimized network**

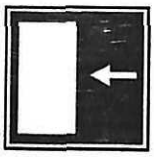
In this example we have separated network into two sub-networks by using Layer 3 device (router). Each interface of router is making single broadcast domain.

2.31 Lesson 31

Common Issues (problems) with large networks are:

- Performance degradation
- Security Issues
- Address Management

Question: If you want to leave the room, what do you have to do?



Answer: You have to go and find out the exit door.

Question: When you want to send data outside the network what does your computer have to do?

Answer: Computer has to find out a door, in computer networks terminology exit door is called ***Gateway.***

Example of Gateway in Computer Networks:

Figure 0:64 show default gateway.

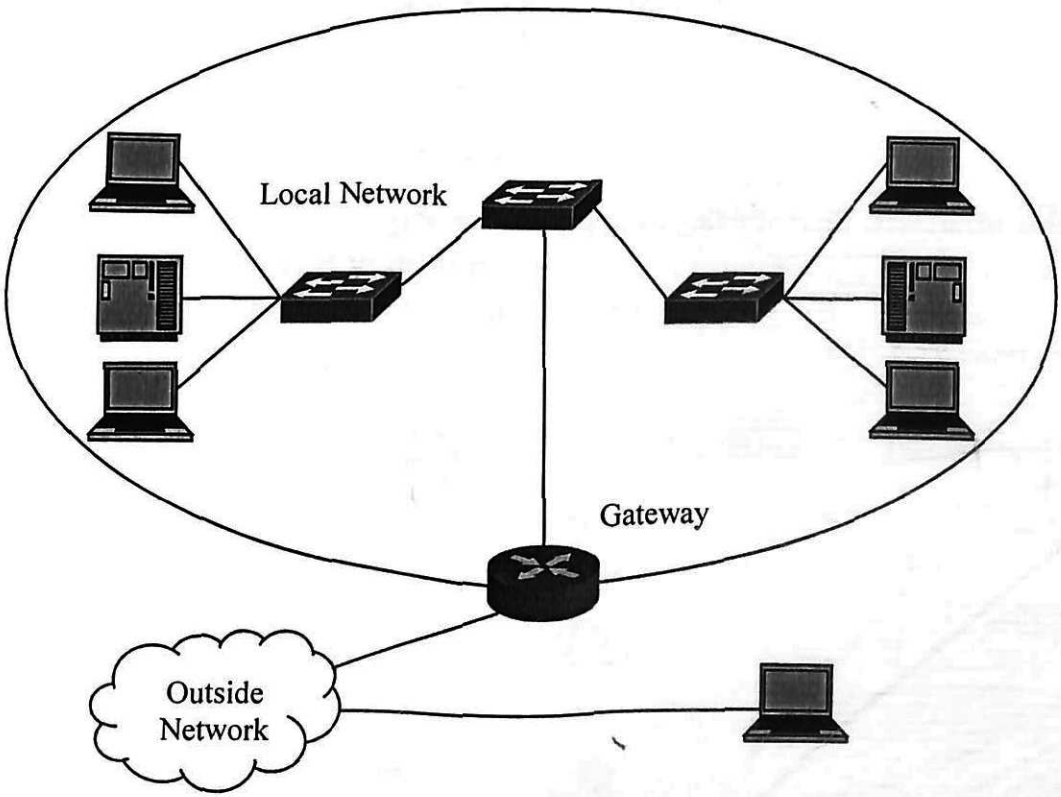


Figure Error! No text of specified style in document.**:64 Default Gateway**

Hosts do not know where to deliver data to devices in a remote network – this is the role of the gateway.

2.32 Lesson 32

Hierarchic Addressing

When we compose letter we have to write address of receiver like:

Letter to: Kazakhstan, Almaty, Kaskelen, SDU, Engineering Faculty, Zhamanov Azamat

By using this hierarchy postman can easily find out receiver. In computer networks addressing we also have hierarchy which consists of two portions: Network portion and Host portion.

Example of Computer Networks hierarchical addressing:
Figure 0:65 show hierarchical structure of IPv4.

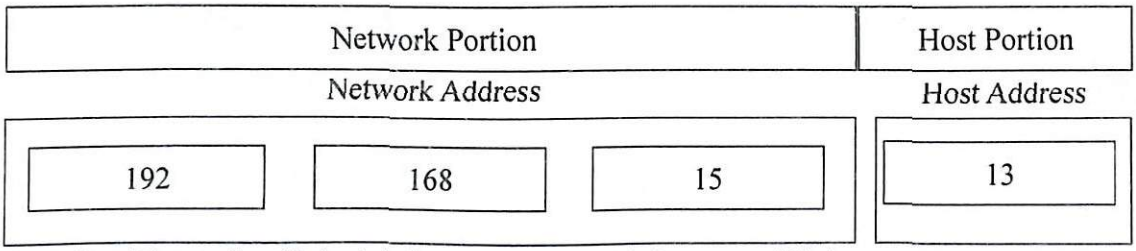


Figure Error! No text of specified style in document.**:65 Hierarchical structure of IPv4**

We will speak about IPv4 addressing later in details.

2.33 Lesson 33

Routing IP packets in process

1st step: In first step Sender prepares packet with destination IP address of Receiver and sends it to local router.

Figure 0:66 show 1st step in routing process.

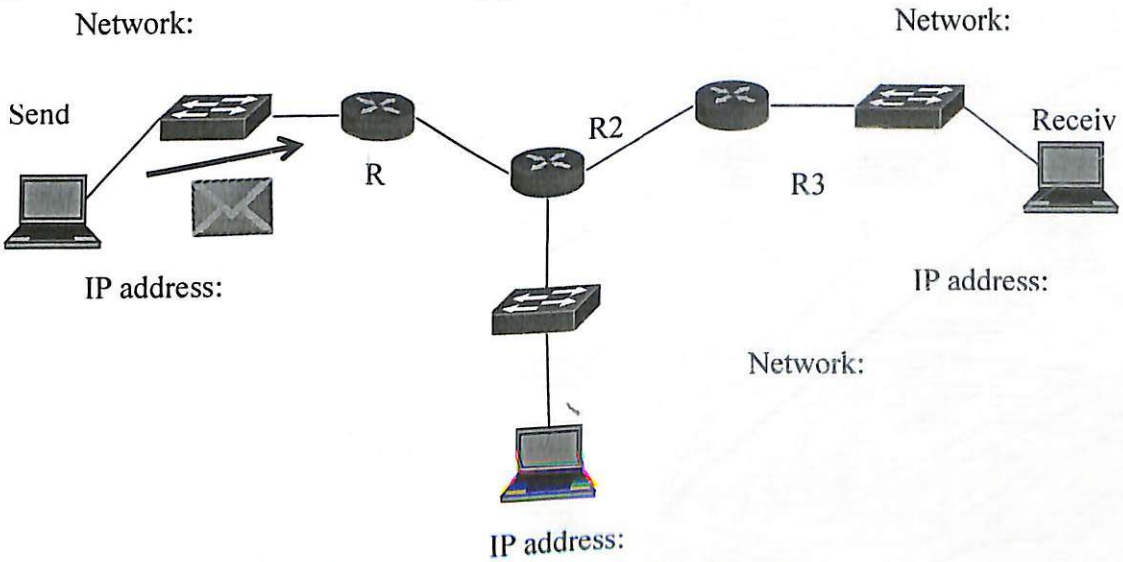


Figure Error! No text of specified style in document.**:66 First step in routing process**

2nd step: R1 receives packet and makes and thinks about destination network.

Figure 0:67 show 2n step of routing process.

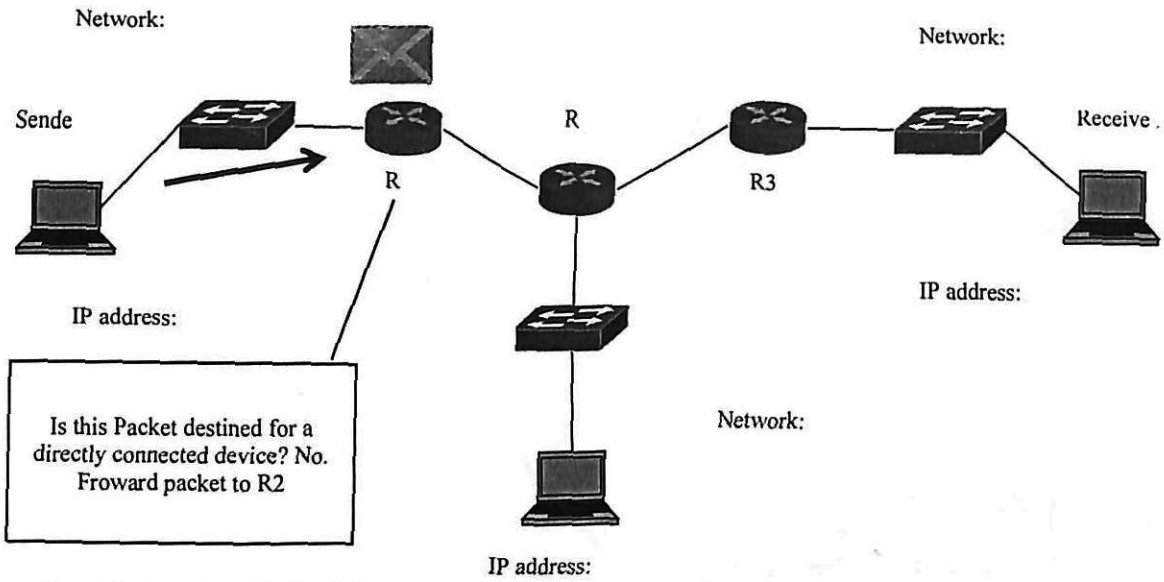


Figure Error! No text of specified style in document.:67 2nd step of routing process

3rd step: R2 receives packet and makes and thinks about destination network.

Figure 0:68 show 3rd step of routing process.

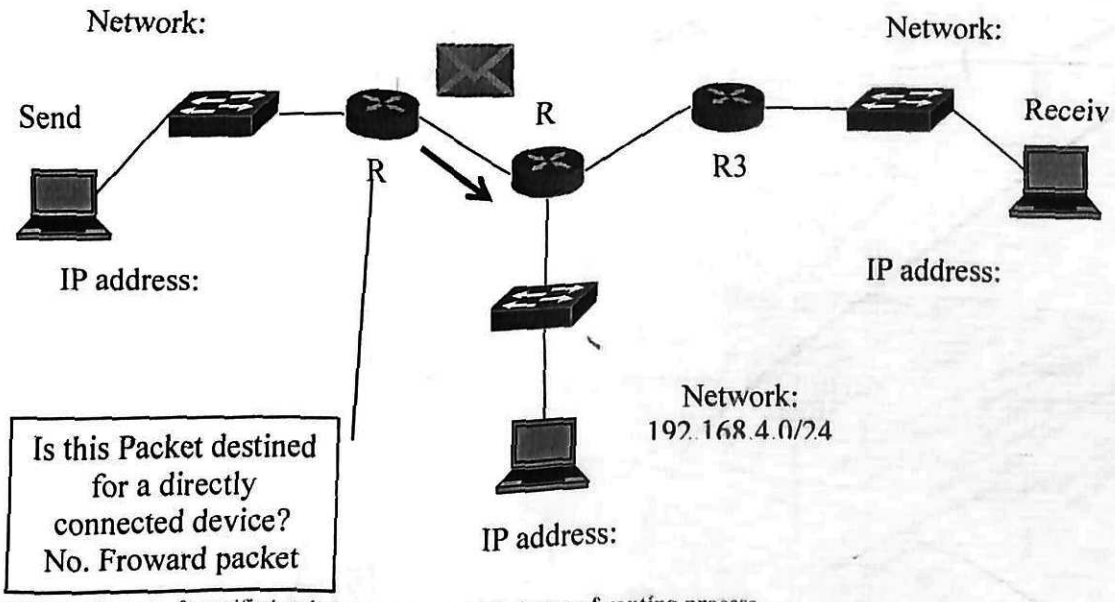


Figure Error! No text of specified style in document.:68 3rd step of routing process

4th step: R3 receives packet and makes and thinks about destination network.

Figure 0:69 show 4th step of routing process.

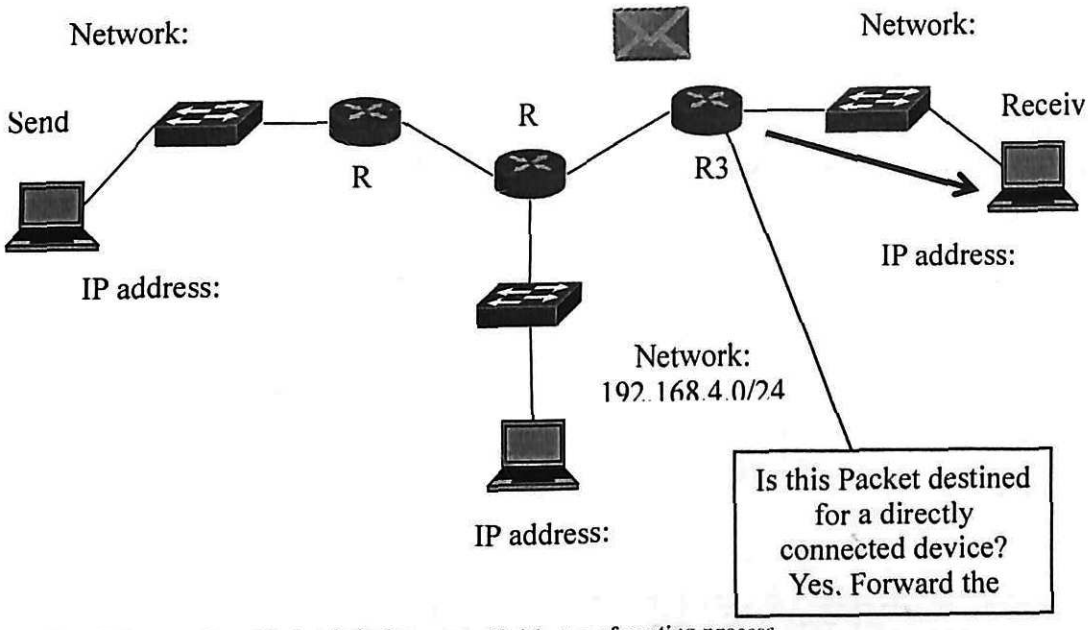
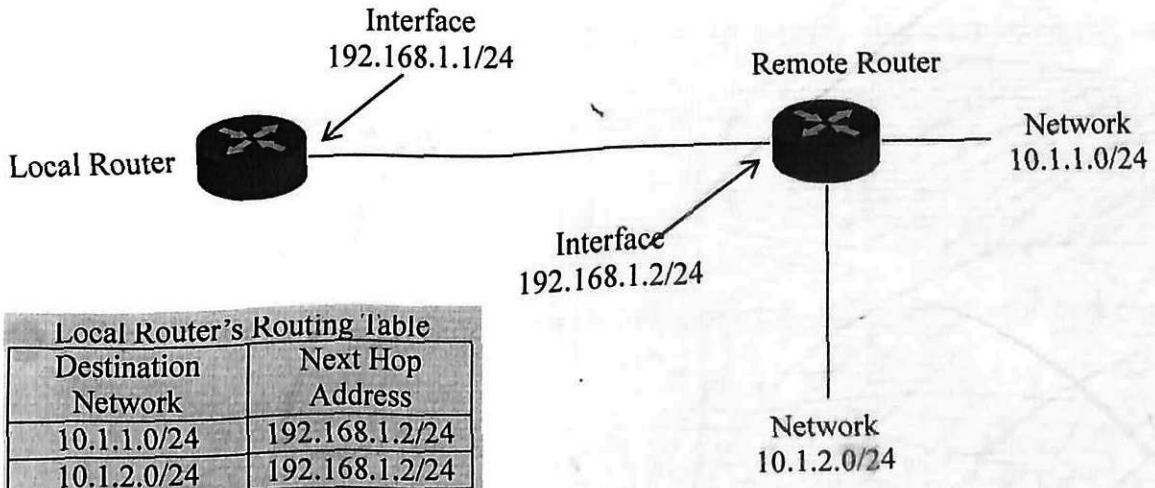


Figure Error! No text of specified style in document.:**69 4th step of routing process**

2.34 Lesson 34

Best Path

Question: How do routers identify best path?
Answer: Routers use routing tables.
Example of Routing table:
Figure 0:70 show routing table.

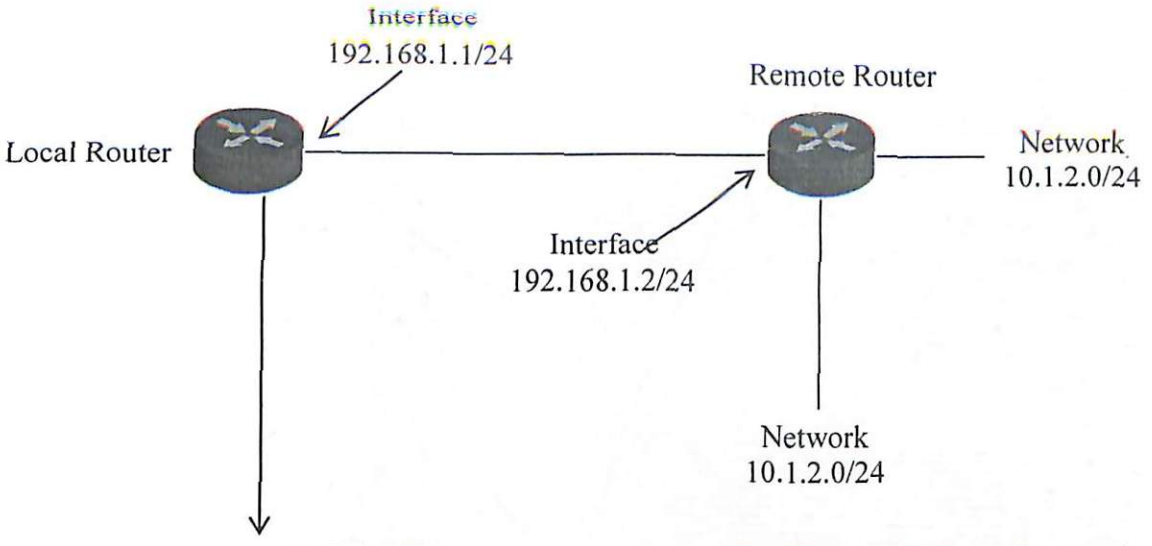


Local Router's Routing Table

Destination Network	Next Hop Address
10.1.1.0/24	192.168.1.2/24
10.1.2.0/24	192.168.1.2/24

Figure Error! No text of specified style in document.:**70 Routing table**

Example output from Cisco Router.
Figure 0:71 show Cisco router output.




```
Router$show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 2 subnets
S       10.1.1.0 [1/0] via 192.168.1.2
S       10.1.2.0 [1/0] via 192.168.1.2
C    192.168.1.0/24 is directly connected, Serial0/0/0
```

Figure Error! No text of specified style in document.**:71 Cisco router output**

In Cisco IOS by using command **show ip route**, you can examine routing table.

In this example we have three rows in routing table:

- S 10.1.1.0/24 [1/0] via 192.168.1.2
- S 10.1.2.0/24 [1/0] via 192.168.1.2
- C 192.168.1.0/24 is directly connected

By using this record in routing table router makes decision where to send packet.

2.35 Lesson 35

Useful Commands:

- ipconfig/all - verifies TCP/IP stack configuration

Figure 0:72 show output of "ipconfig/all" command.

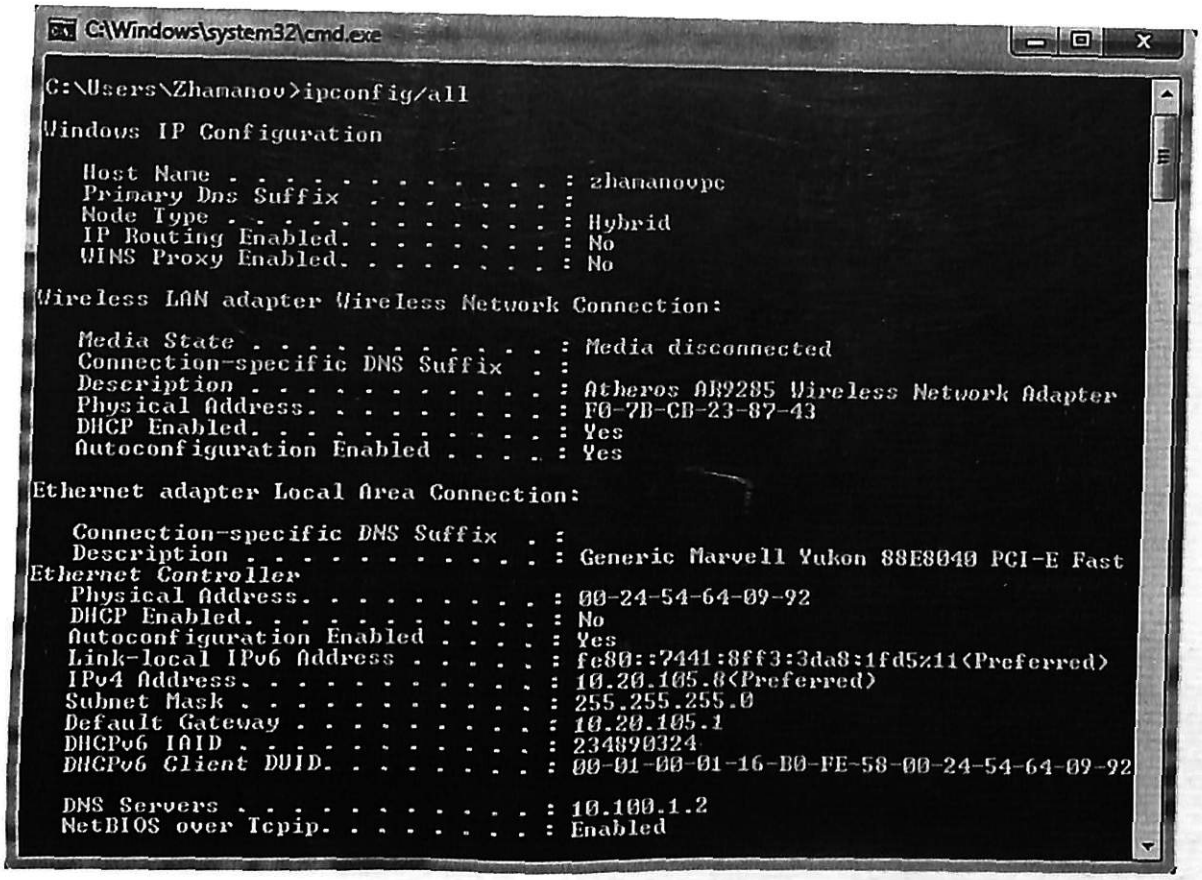


Figure Error! No text of specified style in document.:**72 ipconfig/all command's output**

- netstat - shows Transport layer protocol's connections

Figure 0:73 show netstat command's output.

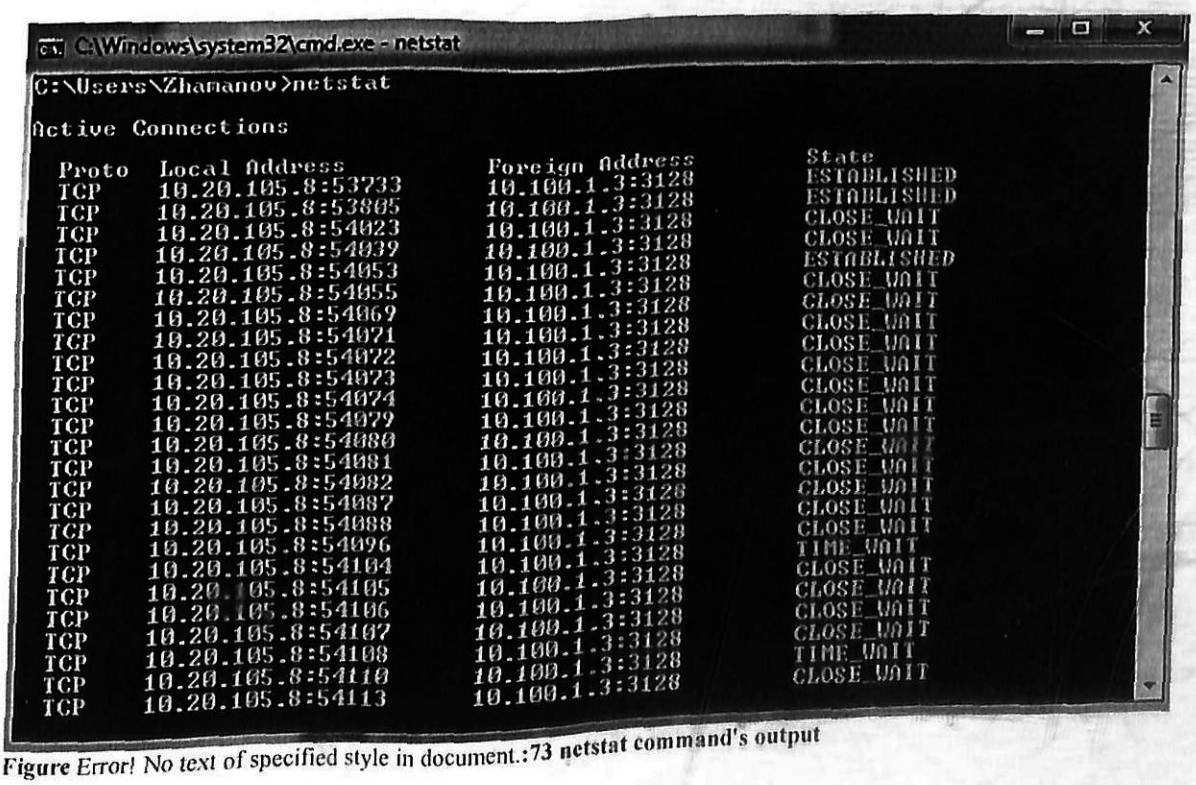


Figure Error! No text of specified style in document.:**73 netstat command's output**

- router print - shows routing table in computer

Figure 0:74 show route print command's output.

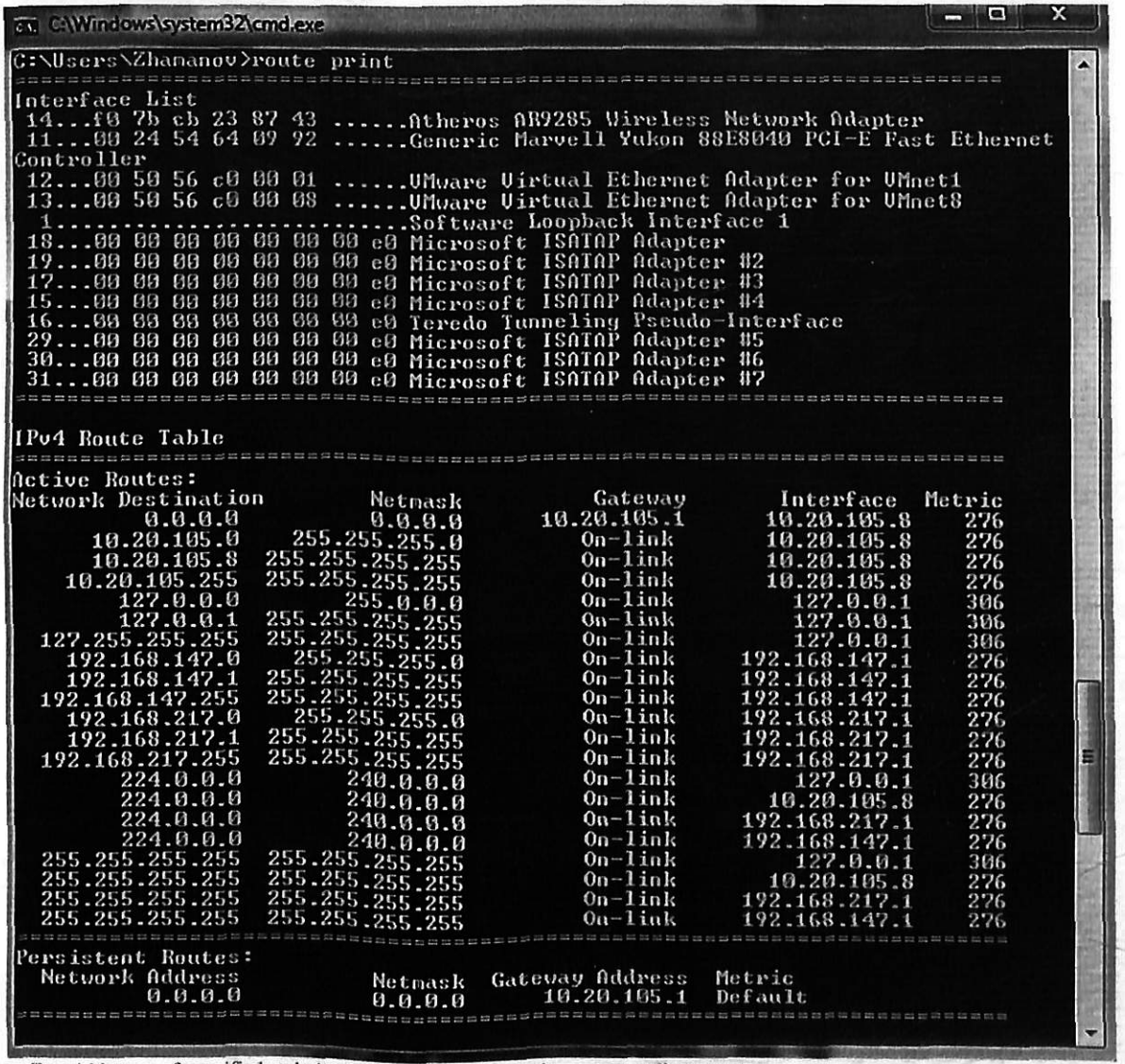


Figure Error! No text of specified style in document.**:74 route print command's output**

Continue of route print output.

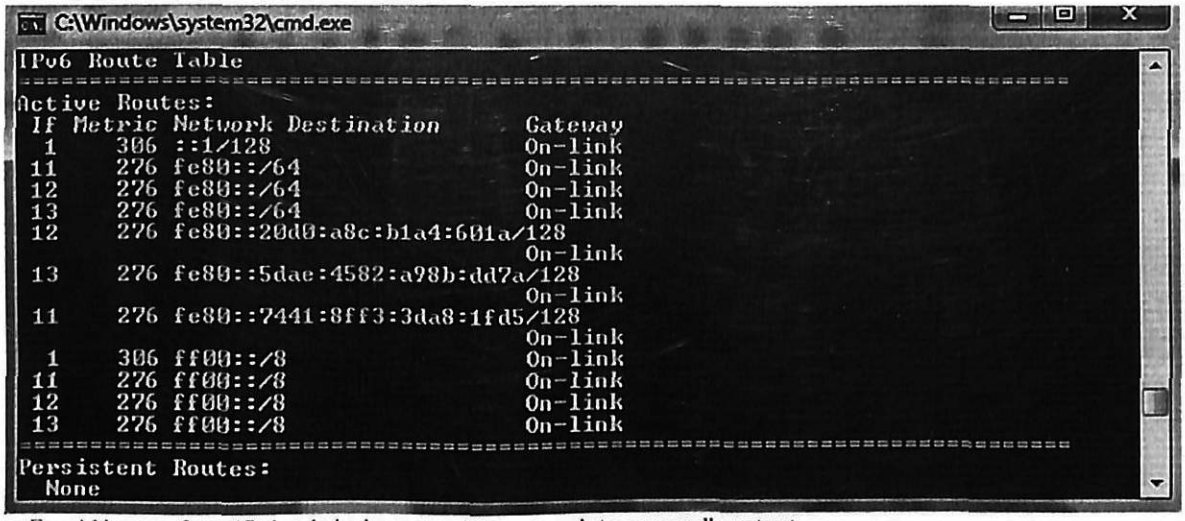


Figure Error! No text of specified style in document.**:75 route print command's output**

CONCLUSION

We see that whole world tries to implement new technologies and techniques in order to improve the education process. And it's actually not important what kind of education it will be. It can be higher education, school education or education at work. Everywhere people try come with time. From my diploma thesis you can see that this hierarchy starts from Computer Based Learning where people started to use computers as the way to improve knowledge. Then with the appearance of internet this process was strongly improved. It gave very big opportunities to people. Now every person unconsciously use the microlearning approach while reading tutorials, forums, wiki , blogs and other things like this.

This process is taking place in our country as well. And I think we have to include it in the system of our education. I mean we have to develop this sphere by giving chances to developers and users. There should be done more researches on this topic and they should be financed by government. Students must have the opportunities to by book.

In future I want to work on microlearning by using mobile phones, because, now most of our students in our university already have their own smartphones and I want to try this method here. We should try and see what kind of problems we can have and how we can solve them. What can we improve? How we can implement this best world practice in our country. We should learn and analyze very well the courses and technologies we teach and then write our own tutorials taking into account our mentality and our possibilities. This process should be systematized.

Moreover this process must be somehow developed depending on our market needs. The process of education must be integrated with business industry according to their needs. Companies must be involved in this procedure as well. If it will be done very well then everyone will gain profit from it. Companies in the result will have highly qualified employees that are able to work without needing to relearn them and universities will be able to give modern knowledge.

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ANNOTATION

The problems in higher education let us know that except many other reasons one of the main reason is the method and technologies instructors use while teaching. In Kazakhstan you can see a problem that many students come to university without appropriate knowledge. This stops the process of education in university. Moreover now is the so called information age. It means that the information itself is increased every day. This is especially true for information technologies field which I tech in university. The technology that you explained yesterday may be not needed tomorrow.

The term microlearning means learning a small amount of information in small unit of time. This is strongly related with e-learning. Microlearning must be based on technologies that allow you to learn information anywhere and at any time. That's why I used mobile technologies while implementing my project.

My master thesis work is the book which is based on microcontent method. The book is developed for the "Computer Networks" course I teach in university for the first year students in the Suleyman Demirel University where the language of instruction is English.

АҢДАТПА

Жоғары білім беруде көптеген проблемалар бар, олардын біреуілері әдістік мәселесі, және де университеттерде қолданған технологиялар. Мектептен унисверситетке келген оқушыларда менің көзқарасым бойынша көптеген проблемалар бар, олардын біреуі: оқуға өте көп ақпарат беріледі.

Микро оқыту ұғымы осы мағынаны жобалайды: өте қысқа уақытта өте кішкентай ақпараттын бөлшегін оқып білу. Онын e-learning пен жақын қатынасы бар. Микро оқыту әдісі оқушыларға әр уақытта және әр жерде қол жетерлік түрде мекендену міндетті. Бұл технологиялардын арасында мобильдік технологиялар.

Менің магистерлік диссертациям, ол Микро оқыту әдіс негізінде кітап. Кітаптын аты "Fundamentals of Computer Networks in Microlearning Style". Кітап Сулейман Демирел атындағы университетте өткізілетің "Компьютер желілер" курсқа арналған. Курс ағылшын тілінде өткізіледі.

АННОТАЦИЯ

Проблемы в высшем образовании дают понять, что помимо многих причин, одной из главных является методика преподавания, а также технологии используемые в университетах. В Казахстане я наблюдаю такую картину, что школьники окончив школу зачастую приходят с очень слабым багажом знаний и это затормаживает их дальнейшее обучение. Другая причина это то, что мы живем в том веке, когда объем информации увеличивается с неимоверной скоростью. Те знания, которые мы получили вчера, сегодня уже могут оказаться устаревшими. Особенно это касается сферы информационных технологий, где каждый день выходят на свет новые технологии.

Понятие микро обучение подразумевает в себе изучение маленькой частички информации в очень короткое время. Оно имеет непосредственную связь с понятием e-learning. Микро обучение должно основываться на технологиях, которые будут давать возможность обучения в любое время и в любом месте. Этим видом технологий являются в первую очередь мобильные технологии.

Моя магистерская диссертация это именно книга, которая в своем контенте будет основываться на понятии микро обучения. Книга предназначено для обучения курса “Основы Компьютерных Сетей” в университете им. Сулеймана Демиреля, где преподавание ведется на английском языке.