

# BA NETWORKING BASICS 12

**District Name:** KAMLOOPS/THOMPSON

**District Number:** 73

**Developed by:** PAUL PORTER

**Date Developed:** NOV-JAN 2003/2004

**School Name:** KAMLOOPS THOMPSON VIRTUAL SCHOOL

**Principal's Name:** MARILYN HOGG

**Board/Authority Approval Date:** 2004/05/17

**Board/Authority Signature:**

**Course Name:** NETWORKING BASICS

**Grade Level of Course:** 12

**Number of Course Credits:** 4

**Number of Hours of Instruction:** 110

**Prerequisite(s):**

**Special Training, Facilities or Equipment Required:**

- 3 workstations which can be configured by students
- 1 hub
- network cables
- Cat 5e cable, rj45 connectors
- Fluke 620 (or equivalent) cable tester
- Cable building tools – rj 45 crimper, cable stripper

**Course Synopsis:**

This course introduces student to basic concepts of computer networking through a detailed examination of the OSI model (Open System Interconnection). Students learn and apply networking skills to network planning, documentation, implementation, and set-up by planning the complete networking (including wiring, hardware, network addressing) of a small elementary school. Students learn some “hands-on” cabling skills and procedures.

**Rationale:** This course gives students a basic introduction to the theories and technologies of modern computer local area and wide area networking. Other than a general interest course for students this course provides a grounding in networking technologies relevant to careers in the Information Technology field.

**Organizational Structure:**

Unit/Topic	Title	Time
Unit 1	Computing Basics /OSI Model	10
Unit 2	Local Area Networks ( <b>LAN</b> )	10
Unit 3	OSI Layers 1 & 2	20
Unit 4	Design and Documentation / Structured Cabling	20
Unit 5	OSI Layer 3	20
Unit 6	OSI Layer 4	10
Unit 7	OSI Layer 5 & 6	10
Unit 8	OSI Layer 7	10
<b>Total Hours</b>		110

**Unit/Topic/Module Descriptions:**

**Unit 1: Computing Basics & The OSI Model** **10 hrs.**

This unit will look at the components of a computer and at the role of computers in a networking system. Students will use the "ground up" approach to learning networking, starting with the most basic component of a network - the computer. The more the students knows about computers, the easier it will be to understand networks and how they are designed and built.

This unit also explains how standards ensure greater compatibility and interoperability between various types of network technologies. In this unit, students will learn how the OSI reference model networking scheme supports networking standards. In addition, students will see how information or data makes its way from application programs (such as spreadsheets) through a network medium (such as wires) to other application programs located on other computers on a network. This unit will discuss the basic functions of each layer of the OSI model. This will serve as a foundation for designing, building, and troubleshooting networks.

**Curriculum Organizers and Learning Outcomes**

**1) The Basics Of Computer Hardware**

*It is expected that students will:*

- identify the major components of a PC
- identify information flow in an idealized computer
- understand the relationship of NICs to PCs
- identify the difference between PC components versus laptop components

**2) The Basics Of Computer Software**

*It is expected that students will:*

- configure network settings required to connect a PC to a network
- configure a web browser

**3) Binary Numbers**

*It is expected that students will:*

- show how binary numbers represent alphanumeric data
- explain the difference between bits and bytes
- convert decimal numbers to binary numbers
- convert binary numbers to decimal numbers

**4) Basic Networking Terminology**

*It is expected that students will:*

- use appropriate basic networking terminology
- demonstrate an understanding of basic networks and networking
- recommend some basic data networking solutions to specific networking problems
- explain the characteristics of local area networks and wide area networks

### **5) Digital bandwidth**

*It is expected that students will:*

- identify different digital bandwidth measurements
- explain media bandwidth differences
- describe the differences in data throughput in relation to digital bandwidth
- calculate data transfer
- explain the importance of bandwidth

### **6) General Model of Communication**

*It is expected that students will:*

- analyze problems in a flow of data using layers
- understand source, destination, and data packets
- explain “media” & “protocol”
- explain the evolution of ISO networking standards

### **7) The OSI Reference Model**

*It is expected that students will:*

- explain the purpose of the OSI reference model
- identify the seven layers of the OSI reference model
- describe the functions of each layer
- describe encapsulation
- identify the names for data at each layer of the OSI model

### **8) Comparison of the OSI Model and the TCP/IP Model**

*It is expected that students will:*

- explain TCP/IP reference model
- identify the layers of the TCP/IP reference model
- describe the comparison of the OSI model and the TCP/IP model
- Use the OSI and the TCP/IP models in the curriculum

## Unit/Topic/Module Descriptions:

### Unit 2: Local Area Networks (LAN)

10hrs

Students will learn about the evolution of the network device used at each layer of the OSI model. How packets flow through each device as they go through the layers will also be covered. Lastly, students will learn about the basic steps in building LANs. As students read, keep in mind that by interconnecting networking devices, LANs provide multiple connected devices (usually PCs) with access to high-bandwidth.

The purpose of this unit is to introduce students to basic LAN devices and data flow, so students can begin thinking about building LANs. When students have completed this chapter, they should have a firm understanding of :

- LAN devices, such as routers, switches and hubs
- The evolution of networking devices
- Basics of data flow
- Basics related to building LANs

### Curriculum Organizers and Learning Outcomes

#### 1) Basic LAN Devices

*It is expected that students will:*

- identify the different lan topologies
- identify the lan devices in a topology: nics, media, repeaters, hubs, bridges, switches, routers
- explain network segments

#### 2) Evolution of Network Devices

*It is expected that students will:*

- explain the evolution of network devices and their evolution in relation to the OSI layers

#### 3) Basics of Data Flow Through LANs

*It is expected that students will:*

- describe the process of encapsulation
- describe packet flow through layer 1,2,3 devices
- describe packet flow through clouds and through layer 1-7 devices
- a data packet's path through all seven layers of a lan

#### 4) Building LANs

*It is expected that students will:*

- build a small network

## Unit/Topic/Module Descriptions:

### Unit 3: OSI Layers 1 & 2

20hrs.

The function of the physical layer is to transmit data by defining the electrical specifications between the source and the destination. Data, which can consist of such things as text, pictures, audio, or video, travels through the wires and is represented by the presence of either electrical pulses on copper conducting wires or light pulses in optical fibers.

This unit will provide a foundation upon which networking at the physical layer of the OSI model can be understood. How data is transmitted through physical media, such as cables and connectors will also be covered. Finally, factors that affect data transmissions, such as line noise, will be discussed.

The network functions that occur at the physical layer of the OSI model will be addressed in this unit. Different types of networking media that are used at the physical layer. These include shielded twisted-pair cable, unshielded twisted-pair cable, coaxial cable, and fiber-optic cable. Network devices, cable specifications, network topologies, collisions, and collision domains can help determine such things as how much data can travel across the network. They can also determine how fast that data travels.

This unit will discuss LAN media and the Institute for Electrical and Electronic Engineers (IEEE) model. It will also cover how the data link layer provides reliable transit of data across a physical link by using the Media Access Control (MAC) addresses. In so doing, the data link layer is concerned with physical (as opposed to network, or logical) addressing, network topology, line discipline (how end systems will use the network link), error notification, ordered delivery of frames, and flow control. In addition, this chapter will cover how the data link layer uses the MAC address to define a hardware or data link address in order for multiple stations to share the same medium and still uniquely identify each other.

In this unit, students will learn about Ethernet, FDDI, and Token Ring, along with the IEEE specifications for each of these technologies. Students will learn about the LAN standards that specify cabling and signaling at the physical and data link layers of the OSI reference model. Students will also be introduced to Layer 2 devices and basic Ethernet 10BASE-T troubleshooting.

#### Curriculum Organizers and Learning Outcomes

##### 1) Basics of Signals and Noise in Communications Systems

*It is expected that students will:*

- compare analog and digital signals
- demonstrate an understanding of the use analog signals to build digital signals
- identify network signal propagation, attenuation, reflection, noise, dispersion, jitter, latency, collision

##### 2) Basics of Encoding Networking Signals

*It is expected that students will:*

- demonstrate an understanding of historical examples of encoding and modern modulation and encoding

##### 3) Most Common LAN Media

*It is expected that students will:*

- explain the characteristics of stp, utp, coaxial cable, optical fiber, wireless communication

##### 4) Cable Specification and Termination

*It is expected that students will explain:*

- the importance purpose of lan media specifications
- the details of tia/eia-568-a

##### 5) Making and Testing Cable

*It is expected that students will:*

- test ethernet 10base-t patch cables with a cable tester
- make and test ethernet 10base-t straight-through patch cable, console patch cable, crossover cable
- demonstrate the features of an advanced cable tester



## Unit/Topic/Module Descriptions:

### Unit 4: Design and Documentation / Structured Cabling

20hrs.

A firm understanding of data flow through the OSI model lays the foundation for learning how to design networks. Layer 1 and 2 concepts are used in designing networks. Network design takes many technologies into consideration (for example, Token Ring, FDDI, and Ethernet). For example, a Layer 1 LAN topology must be developed. The type of cable and the physical topology (wiring) must be determined.

This unit discusses how the physical and logical topologies of the network should be designed and documented. Techniques such as brainstorming ideas for documentation, problem solving matrices, and other notes will be used. Wiring closet specifications used in LANs, and wiring and electrical techniques used in network building, will also be featured.

This unit shows how to use appropriate and recommended techniques for dressing and securing the cable. Included in this will be the use of cable ties, cable support bars, wire management panels, and releasable Velcro straps. This unit will show that when RJ-45 jacks are used at the telecommunications outlet in a horizontal cabling scheme, the wiring sequence is critical for optimal network performance. A wiring closet serves as the center point of a star topology for the wiring and wiring equipment used for connecting devices in a network. Using this information, wiring closets can be designed for wiring a data or voice network. The equipment found in a wiring closet can include patch panels, wiring hubs, bridges, switches, and routers.

#### Curriculum Organizers and Learning Outcomes

##### 1) Basic Network Design and Documentation

*It is expected that students will:*

- describe general design process
- explain network design issues
- demonstrate an understanding of network design documents and general network design process

##### 2) Planning Structured Cabling:

*It is expected that students will:*

- identify wiring closet specifications
- identify potential wiring closets from a number of possible rooms
- describe the characteristics of horizontal and backbone cabling
- explain the relationship between electricity and grounding
- explain the importance of cabling and grounding

##### 3) Network Power Supply Issues:

*It is expected that students will:*

- identify specific power line problems
- explain the functions and appropriate application of surge suppressors and uninterruptible power supply (ups)

##### 4) Cable installation

*It is expected that students will:*

- describe the basics of project planning
- demonstrate an understanding of:
  - rj-45 jack and outlet installation
  - the basics of cable installation
  - structured cable run installation
  - stringing, running, and mounting cable
  - the basics of wiring closets and patch panels
  - proper wiring closet location
  - the range of equipment for testing structured cabling projects

## Unit/Topic/Module Descriptions:

### Unit 5: OSI Layer 3

20 hrs

The network layer is responsible for navigating data through the network. The function of the network layer is to find the best path for the data to take through the network. The network layer also defines the devices that determine the destination of data as it moves through the network. In this unit, students will learn about the router's use and operations in performing the key internetworking function of the Open System Interconnection (OSI) reference model's network layer, Layer 3.

IP addressing and the three classes of networks in IP addressing schemes will also be discussed. Some IP addresses have been set aside by the American Registry for Internet Numbers (ARIN) and cannot be assigned to any network. Finally, subnetworks and subnet masks and their IP addressing schemes will be explored.

In addition, this unit discusses how devices on local-area networks (LANs) use Address Resolution Protocol (ARP) before forwarding data to a destination. It will teach what happens when a device on one network does not know the MAC address of a device on another network. This chapter also teaches that the Reverse Address Resolution Protocol (RARP) is the protocol a device uses when it does not know its own IP address. Lastly, it covers the difference between routing and routed protocols and how routers track distance between locations. This unit also discusses distance-vector, link-state, and hybrid routing approaches and how each resolves common routing problems.

### Curriculum Organizers and Learning Outcomes

#### 1) Importance of a Network Layer

*It is expected that students will:*

- explain the concepts of segmentation and autonomous systems
- describe communication between separate networks
- identify layer 3 network devices

#### 2) Path Determination

*It is expected that students will:*

- explain the concepts of path determination and network layer addressing
- explain layer 3 and computer mobility
- compare flat and hierarchical addressing

#### 3) IP Address within the IP Header

*It is expected that students will explain:*

- network layer datagrams
- network layer fields
- ip header source and destination fields
- ip addresses as 32-bit binary numbers
- ip address component fields

#### 4) IP Address Classes

*It is expected that students will:*

- explain ip address classes and ip addresses as decimal numbers
- convert decimal ip addresses to binary equivalents and binary ip addresses to decimal equivalents

#### 5) Reserved Address Space

*It is expected that students will:*

- describe the purposes of network ids and broadcast addresses
- explain the proper use of hosts for classes of ip addresses

#### 6) Basics of Subnetting

*It is expected that students will:*

- explain classical ip addressing
- describe the purpose for subnetting and subnet masking
- explain boolean operations: “and”, “or”, and “not”
- use the “and” function to determine subnets



## 7) Creating a Subnet

*It is expected that students will:*

- determine the range of bits needed to create subnets and subnet mask size
- compute subnet mask and ip address and hosts per subnetwork
- use the boolean “and” operation
- configure ip addressing on a network diagram using appropriate host/subnet schemes
- explain private addresses

## 8) Layer 3 Devices

*It is expected that students will:*

- identify the basic characteristics of routers and router interfaces/ports

## 9) Network-to-Network Communications

*It is expected that students will:*

- analyse methods for assigning an ip address
- understand the dhcp initialization sequence
- explain the function of the address resolution protocol (arp) and arp operation within a subnet

## 10) Advanced ARP Concepts

*It is expected that students will:*

- explain default gateway
- identify problems with sending data to nodes on different subnets
- describe how arp sends data to remote networks
- explain proxy arp

## 11) Routable Protocols

*It is expected that students will:*

- describe the characteristics of routed protocols and nonroutable protocols

## 12) Routing Protocols

*It is expected that students will:*

- define routing protocol encapsulation sequence
- describe multi-protocol routing

## 13) Other Network Layer Services

*It is expected that students will:*

- describe connectionless network services and connection-oriented network services
- compare connectionless and connection-oriented network processes
- explain the relationship between ip and the transport layer

## 14) ARP Tables

*It is expected that students will:*

- compare router arp tables with arp tables kept by other networking devices
- describe other router table addresses
- explain the purpose of arp requests and arp replies, proxy arp, and indirect routing

## 15) Interior Gateway Protocol (IGP) and Exterior Gateway Protocol (EGP)

*It is expected that students will:*

- describe some of the characteristics of igps & egps: rip, igrp, eigrp,ospf
- explain how routers recognize networks
- explain examples of static routing and dynamic routing
- show how routers use rip to route data through a network

## 16) Protocol Analyzer Software

*It is expected that students will:*

- use protocol analyzer software for arps and broadcasts

**Unit/Topic/Module Descriptions:**

**Unit 6:** OSI Layer 4,5 & 6

10 hrs

This unit discusses the functions of the transport layer and the different processes that occur as data packets travel through this layer. More specifically:

- The transport layer regulates information flow to ensure end-to-end connectivity between host applications reliably and accurately.
- The TCP/IP protocol of Layer 4 (transport layer) has two protocols. They are TCP and UDP.
- TCP and UDP use port (or socket) numbers to keep track of different conversations that cross the network at the same time, to pass information to the upper layers.
- The three-way handshake sequence synchronizes a logical connection between the endpoints of a network.

This unit should provide a firm understanding of how the transport layer provides transport services from the host to the destination, which is often referred to as end-to-end services.

In this unit, students will learn about the control mechanisms provided by the session layer (Layer 5) of the OSI model. Included are accounting control, conversation control (determining which device can talk when), and session parameter negotiation. The unit also describes how the session layer coordinates service requests and responses which occur when applications communicate between different hosts. Students will learn about the processes that take place as data travels through the session layer, including dialogue control and dialogue separation that enable applications to communicate between the source and destination.

This unit will look at Layer 6, the presentation layer. This layer provides services that allow communication between applications on diverse computer systems in a manner that is transparent to the applications.

The presentation layer is concerned with the format and representation of data. If necessary, this layer can translate between different data formats. The presentation layer provides code formatting and conversion, which is used to make sure that applications have meaningful information to process. Layer 6 is also concerned with the data structures that are used by applications. To better understand this, students will learn how Layer 6 arranges and organizes data before it is transferred.

Curriculum Organizers and Learning Outcomes

### 1)The Transport Layer

*It is expected that students will:*

- purpose of the transport layer
- layer 4 protocols
- compare tcp and ip

### 2) TCP and UDP

*It is expected that students will:*

- identify tcp and udp segment format

### 3) TCP Connection Methods

*It is expected that students will:*

- describe the function of port numbers and three-way handshake/open connection

### 4) The Session Layer

*It is expected that students will:*

- explain dialogue control and dialogue separation
- describe other layer 5 protocols

### 5) The Presentation Layer

*It is expected that students will:*

- describe presentation layer functions and standards
- identify file formats used at this layer
- identify basic data encryption and compression

## Unit/Topic/Module Descriptions:

Unit 8: OSI Layer 7

10 hrs



## **Instructional Component:**

- on-line curriculum access
- direct instruction
- hands-on labs
- indirect instruction
- analysis of networking practices in various locations
- interactive on-line labs

## **Assessment Component:**

### **Exams**

60% 13 - on-line objective and subjective item tests

40% 1 – mid-term exam, 1 – final exam

### **Labs**

#### **Paper/theory labs**

- 1.3.6 Binary Numbers
- 2.3.4 OSI Model
- 2.3.5 OSI Model
- 10.4.1 IP Addressing
- 10.6.6 Subnet Masking
- 10.7.5 Subnet Masking
- 10.7.7 Subnet Masking

#### **Interactive on-line labs**

- 2.3.5 OSI Model
- 3.1.11 LAN Topology
- 7.5.4 Collision Domains
- 9.2.1 Structured Cabling
- 10.5.5 IP Address Classes
- 10.7.5 Subnetting Class B IP Addresses
- 10.7.6 Subnetting in Action
- 10.7.7 Subnetting Class C IP Addresses
- 15.3.1 Application Layer Software
- 15.3.3 DNS Lookup Sequence

**Hands-on Labs** - these must be done with the instructor.

- cable building- patch cable, cross-over cable
- Fluke cable tester
- small network set-up

### **Projects**

- Network Design - Wiring Project – basic LAN design for a multi-building elementary school.
- Sunset Elementary Wiring Project - Network Specifications
- Sunset Elementary Wiring Project - Schematic Map
- This will require the student to plan the wiring, select the actual equipment, and assign basic addressing for a multi-building elementary school.

All labs and the project must be satisfactorily completed in order to receive credit for the course.

## **Learning Resources:**

- On-line curriculum
- Cisco Academy Text – available to students
- Networking manuals and study guides

## **Additional Information:**