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NETWORK AND CYBER SECURITY



01 - Introduction to TCP/IP Networking

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Network Fundamentals (High Level Introduction)

- ▶ Networking refers to connected computing devices that communicate with each other to exchange information. (Data, Video, Voice)
- ▶ Network types: PAN (Personal), LAN(Local)/WLAN(Wireless), CAN(Campus), MAN(Metro), WAN(Wide)
- ▶ Networks work correctly because the various devices and software follow rules. Those rules come in the form of standards and protocols, which are agreements of a particular part of how a network should work.
- ▶ TCP/IP is the most used networking model today. You can find support for TCP/IP on practically every computer operating system (OS) in existence today, from mobile phones to mainframe computers. Every network built using Cisco products today supports TCP/IP.

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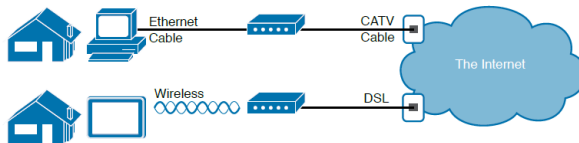
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End-user perspectives on Networking

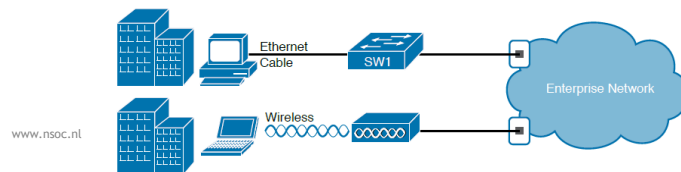
► Networking at home (SOHO)

- The smaller networks at home, when used for business purposes, often go by the name **small office/home office (SOHO)** networks.



► Networking at the office (Enterprise)

- A network created by one corporation, or enterprise, for the purpose of allowing its employees to communicate, is called an **Enterprise** network.



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TCP/IP Networking Model

- A networking model, sometimes also called either a networking architecture or networking blueprint, refers to a comprehensive set of documents.
- These documents define everything that should happen for a computer network to work.
- Some documents define a protocol, which is a set of logical rules that devices must follow to communicate.
 - *A document could define the voltage and current levels used on a particular cable when transmitting data.*

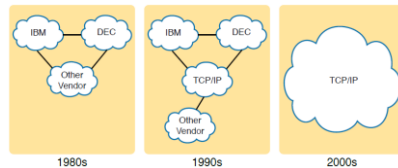
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History to TCP/IP

- ▶ Today almost all computer networking uses the TCP/IP networking model.
- ▶ Long time ago, and still happening, vendors created their own networking protocols; these protocols supported only that vendor's computers.



- ▶ The International Organization for Standardization (ISO), created the Open Systems Interconnection (OSI) networking model, to standardize data networking protocols to allow communication among all computers.
- ▶ The U.S. Department of Defense (DoD) created a second networking model, called TCP/IP.

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Overview of the TCP/IP Networking Model

- ▶ The TCP/IP model both defines and references a large collection of protocols that allow computers to communicate. To define a protocol, TCP/IP uses documents called Requests For Comments (RFC).
- ▶ The TCP/IP model creates a set of rules that allows us all to take a computer (or mobile device) out of the box, plug in all the right cables, turn it on, and connect to and use the network.
- ▶ To understand a networking model, each model breaks the functions into a small number of categories called layers. Each layer includes protocols and standards that relate to that category of functions.
 - ▶ The bottom layer focuses on how to transmit bits over each individual link.
 - ▶ The data-link layer focuses on sending data over one type of physical link.
 - ▶ The network layer focuses on delivering data over the entire path from the original sending computer to the final destination computer.
 - ▶ The top two layers focus more on the applications that need to send and receive data.

TCP/IP Model

Application

Transport

Network

Data Link

Physical

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Network Model Layer Interaction

TCP/IP Model

Application
Transport
Network
Data Link
Physical

Example Protocols

HTTP, POP3, SMTP

TCP, UDP

IP, ICMP

Ethernet, 802.11 (Wi-Fi)

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TCP/IP Model

Application
Transport
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Concept	Description
Same-layer interaction on different computers	The two computers use a protocol to communicate with the same layer on another computer. The protocol defines a header that communicates what each computer wants to do.
Adjacent-layer interaction on the same computer	On a single computer, one lower layer provides a service to the layer just above. The software or hardware that implements the higher layer requests that the next lower layer perform the needed function.

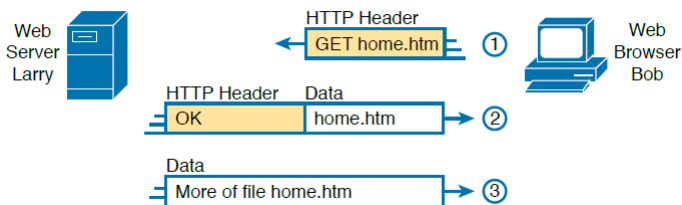
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TCP/IP Application Layer

- ▶ TCP/IP application layer protocols provide services to the application software running on a computer.
- ▶ The application layer does not define the application itself, but it defines services that applications need.
- ▶ The application layer provides an interface between software running on a computer and the network itself.
- ▶ *Example: application protocol HTTP defines how web browsers can pull the contents of a web page from a web server.*



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TCP/IP Transport Layer

- ▶ The two most commonly used transport layer protocols are the Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP).
- ▶ Transport layer protocols provide services to the application layer protocols that reside one layer higher in the TCP/IP model.

TCP	UDP
Sequenced	Unsequenced
Reliable	Unreliable
Connection-oriented	Connectionless
Virtual circuit	Low overhead
Acknowledgements	No acknowledgements
Windowing flow control	No windowing or flow control

TCP Segment Header Format									
Bit #	0	7	8	15	16	23	24	31	
0	Source Port				Destination Port				
32	Sequence Number								
64	Acknowledgment Number								
96	Data Offset	Res	Flags				Window Size		
128	Header and Data Checksum				Urgent Pointer				
160	Options								

UDP Datagram Header Format									
Bit #	0	7	8	15	16	23	24	31	
0	Source Port				Destination Port				
32	Length				Header and Data Checksum				

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TCP/IP Network Layer

- ▶ The TCP/IP network layer includes a small number of protocols, but only one major protocol: the Internet Protocol (IP).
- ▶ IP provides several features, most importantly, addressing and routing.
- ▶ IP defines that each host computer should have a different IP address.
- ▶ IP defines the process of routing so that devices called routers can forwarding packets of data so that they are delivered to the correct destinations.
- ▶ The network layer defines the details of how a network infrastructure should be created so that the network can deliver data to all computers in the network.

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IP Addressing Basics

- ▶ Each device that uses TCP/IP—each TCP/IP host—needs a unique address so that it can be identified in the network.
- ▶ Each **IP address has four numbers**, separated by periods (.).
- ▶ *Example: 10.10.10.2, 192.168.1.1, 1.1.1.1, 8.8.8.8*
- ▶ This style of number is called a **dotted-decimal notation (DDN)**.
- ▶ To route IP-addresses a device called router is needed.
- ▶ Routers are networking devices that connect the parts of the TCP/IP network together for the purpose of routing (forwarding) IP packets to the correct destination.
- ▶ They receive IP packets on various physical interfaces, make decisions based on the IP address included with the packet, and then physically forward the packet out some other network interface.

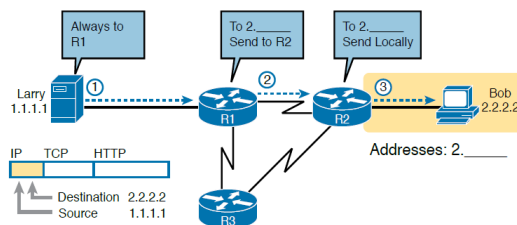
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IP Routing Basics

- ▶ The TCP/IP network layer, using the IP protocol, provides a service of forwarding IP packets from one device to another. Any device with an IP address can connect to the TCP/IP network and send packets.



- ▶ Router R1 receives the IP packet, and R1's IP process makes a decision. R1 looks at the destination address (2.2.2.2), compares that address to its known IP routes, and chooses to forward the packet to Router R2. This process of forwarding the IP packet is called IP routing (or simply routing).

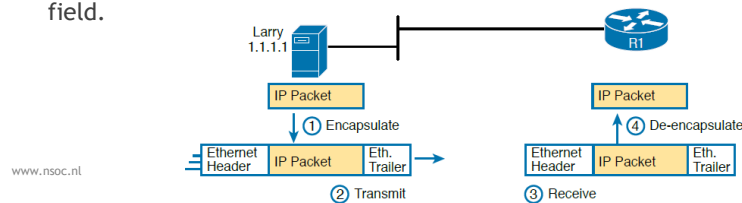
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TCP/IP Data-Link and Physical Layers

- ▶ The TCP/IP model's data-link and physical layers define the protocols and hardware required to deliver data across some physical network.
- ▶ The physical layer defines the cabling and energy that flow over the cables (or air).
- ▶ When a host's or router's IP process chooses to send an IP packet to another router or host, that host or router then uses link-layer details to send that packet to the next host/router.
- ▶ The datalink layer encapsulate the IP packet into a frame.
- ▶ While all other layers has only a header field, the link layer has also a trailer field.

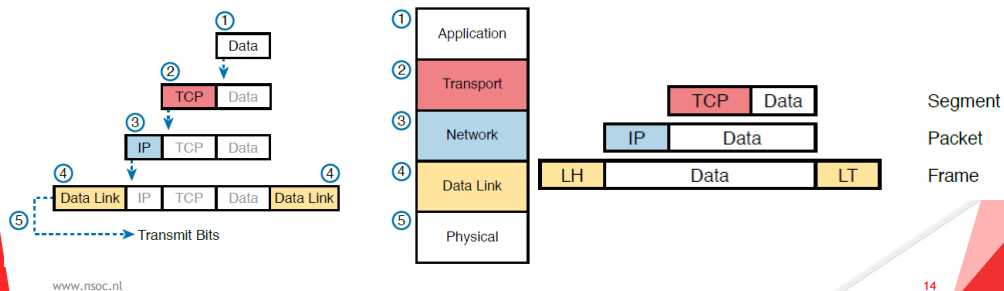


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Data Encapsulation Terminology

- ▶ As HTTP, TCP, IP, and Ethernet do their jobs, when sending data, each layer adds its own header (and for data-link protocols, also a trailer) to the data supplied by the higher layer.
- ▶ The term encapsulation refers to the process of putting headers (and sometimes trailers) around some data.



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OSI Network Model and Terminology

- ▶ Many vendors and protocol documents started using terminology from the OSI model.
- ▶ The OSI model has many similarities to the TCP/IP model.
- ▶ It has 7 layers (OSI-7), and each layer defines a set of typical networking functions.
- ▶ Multiple protocols and standards that implement the functions specified by each layer.

OSI		TCP/IP	
7	Application	5 - 7	Application
6	Presentation		
5	Session		
4	Transport	4	Transport
3	Network	3	Network
2	Data Link	2	Data Link
1	Physical	1	Physical

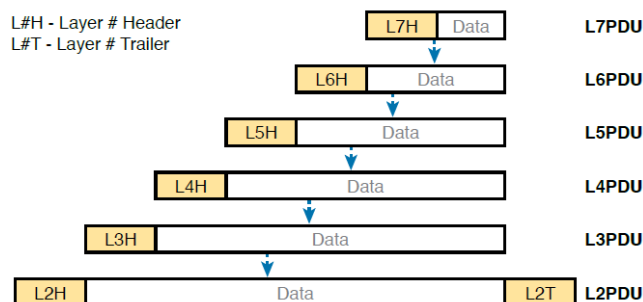
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OSI Data Encapsulation Terminology

- ▶ Like TCP/IP, each OSI layer asks for services from the next lower layer.
- ▶ OSI uses a more generic term to refer to messages, rather than frame, packet, and segment.
- ▶ OSI uses the term protocol data unit (PDU).
- ▶ A PDU represents the bits that include the headers and trailers for that layer, as well as the encapsulated data.



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Questions?

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