Chapter 3: Network Protocols and Communications

Introduction to Networks
Chapter 3

3.1 Rules of Communication
3.2 Network Protocols and Standards
3.3 Moving Data in the Network
3.4 Summary
Chapter 3: Objectives

Students will be able to:

- Explain how rules are used to facilitate communication.
- Explain the role of protocols and standards organizations in facilitating interoperability in network communications.
- Explain how devices on a LAN access resources in a small to medium-sized business network.
Network Protocols and Standards
Standards Organizations

- IEEE
- IETF
- EIA
- TIA
- ITU
- ICANN
- IANA

3.0.1.2
The Rules
What is Communication?

Human Communication

Message Source -> Transmitter -> Transmission Medium -> Receiver -> Message Destination

Do animations on buttons on 3.1.1.1
The Rules

Establishing the Rules

- An identified sender and receiver
- Agreed upon method of communicating (face-to-face, telephone, letter, photograph)
- Common language and grammar
- Speed and timing of delivery
- Confirmation or acknowledgement requirements
The Rules
Message Encoding

Do animations on buttons on 3.1.1.3
The Rules
Message Formatting and Encapsulation

Example: Personal letter contains the following elements:

- An identifier of the recipient
- A salutation or greeting
- The message content
- A closing phrase
- An identifier of the sender
The Rules

Message Size

The size restrictions of frames require the source host to break a long message into individual pieces that meet both the minimum and maximum size requirements.

This is known as segmenting.

Each segment is encapsulated in a separate frame with the address information, and is sent over the network.

At the receiving host, the messages are de-encapsulated and put back together to be processed and interpreted.

Do animations on buttons on 3.1.1.5
The Rules

Message Timing

- Access Method
- Flow Control
- Response Timeout

Do buttons on 3.1.1.6
The Rules

Message Delivery Options

Do animations on buttons on 3.1.1.7
Protocols

Rules that Govern Communications

Protocols: Rules that Govern Communications

Content Layer

Where is the café?

Conversation protocol suite
1. Use a common language
2. Wait your turn
3. Signal when finished

Rules Layer

Physical Layer

Protocol suites are sets of rules that work together to help solve a problem.
Protocols

Network Protocols

- How the message is formatted or structured
- The process by which networking devices share information about pathways with other networks
- How and when error and system messages are passed between devices
- The setup and termination of data transfer sessions

Know the protocols on 3.2.1.3
Protocols

Interaction of Protocols

- Application Protocol – Hypertext Transfer Protocol (HTTP)
- Transport Protocol – Transmission Control Protocol (TCP)
- Internet Protocol – Internet Protocol (IP)
- Network Access Protocols – Data Link & Physical layers
Protocol Suites

Protocol Suites and Industry Standards

<table>
<thead>
<tr>
<th>TCP/IP</th>
<th>ISO</th>
<th>AppleTalk</th>
<th>Novell Netware</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>HTTP</td>
<td>ACSE</td>
<td>AFP</td>
</tr>
<tr>
<td></td>
<td>DNS</td>
<td>ROSE</td>
<td></td>
</tr>
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<td></td>
<td>DHCP</td>
<td>TRSE</td>
<td></td>
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<td>FTP</td>
<td>SESE</td>
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<td>NDS</td>
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<td></td>
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<td>4</td>
<td>TCP</td>
<td>TP0</td>
<td>ATP AEP</td>
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<tr>
<td></td>
<td>UDP</td>
<td>TP1</td>
<td>NBP RTMP</td>
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<td></td>
<td></td>
<td>TP2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TP3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TP4</td>
<td></td>
</tr>
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<td>3</td>
<td>IPV4</td>
<td>CONP/CNMS</td>
<td></td>
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<td>IPV6</td>
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<td>ICMPV4</td>
<td>CLNP/CLNS</td>
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<td>ICMPV6</td>
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<td>SPX</td>
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<td>1</td>
<td>Ethernet</td>
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<tr>
<td></td>
<td>PPP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frame Relay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATM</td>
<td></td>
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<tr>
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<td>WLAN</td>
<td></td>
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</table>
Protocol Suites
Creation of Internet, Development of TCP/IP
Protocol Suites

TCP/IP Protocol Suite and Communication

Do buttons and animations on 3.2.2.3
Protocol Suites

TCP/IP Protocol Suite and Communication

Do Drag and drop activity on 3.2.2.4
Standards Organizations

Open Standards

- The Internet Society (ISOC)
- The Internet Architecture Board (IAB)
- The Internet Engineering Task Force (IETF)
- Institute of Electrical and Electronics Engineers (IEEE)
- The International Organization for Standards (ISO)
Standards Organizations

ISOC, IAB, and IETF

Internet Society (ISOC)

Internet Architecture Board (IAB)

Internet Engineering Task Force (IETF)
- Internet Engineering Steering Group (IESG)
  - Working Group #1
  - Working Group #2
  - Working Group #3

Internet Research Task Force (IRTF)
- Internet Research Steering Group (IRSG)
  - Research Group #1
  - Research Group #2
  - Research Group #3
Standards Organizations

IEEE

- 38 societies
- 130 journals
- 1,300 conferences each year
- 1,300 standards and projects
- 400,000 members
- 160 countries
- IEEE 802.3
- IEEE 802.11
Standards Organizations

IEEE

### IEEE 802 Working Groups and Study Groups

- 802.1 Higher Layer LAN Protocols Working Group
- 802.3 Ethernet Working Group
- 802.11 Wireless LAN Working Group
- 802.15 Wireless Personal Area Network (WPAN) Working Group
- 802.16 Broadband Wireless Access Working Group
- 802.18 Radio Regulatory TAG
- 802.19 Wireless Coexistence Working Group
- 802.21 Media Independent Handover Services Working Group
- 802.22 Wireless Regional Area Networks
- 802.24 Smart Grid TAG

---

Important:
802.3 – Ethernet
802.11 - Wireless
Standards Organizations
ISO

Important:
This model is our basis for discussing networking!

OSI Model

<table>
<thead>
<tr>
<th>Host Layers</th>
<th>Media Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>data</td>
<td>packets</td>
</tr>
<tr>
<td>presentation</td>
<td>frames</td>
</tr>
<tr>
<td>session</td>
<td>bits</td>
</tr>
<tr>
<td>transport</td>
<td>physical</td>
</tr>
<tr>
<td>network</td>
<td>data link</td>
</tr>
<tr>
<td>segments</td>
<td>physical (MAC &amp; LLC)</td>
</tr>
<tr>
<td></td>
<td>Media, Signal and Binary Transmission</td>
</tr>
</tbody>
</table>

- **data**: Network Process to Application
- **presentation**: Data Representation & Encryption
- **session**: Interhost Communication
- **transport**: End-to-End Connections and Reliability
- **network**: Path Determination & Logical Addressing (IP)
- **frames**: Physical Addressing (MAC & LLC)
- **bits**: Media, Signal and Binary Transmission

3.2.3.4
## OSI in a Nutshell

<table>
<thead>
<tr>
<th>Layer</th>
<th>Keyword(s)</th>
<th>Device</th>
<th>Protocol Data Unit</th>
<th>TCP/IP Utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Application</td>
<td>Web Browser</td>
<td>Computer</td>
<td>Data</td>
</tr>
<tr>
<td>6</td>
<td>Presentation</td>
<td>common data format</td>
<td></td>
<td>Data</td>
</tr>
<tr>
<td>5</td>
<td>Session</td>
<td>dialing the phone</td>
<td></td>
<td>Data</td>
</tr>
<tr>
<td>4</td>
<td>Transport</td>
<td>Flow Control</td>
<td>Segments</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reliability</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sequencing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Network</td>
<td>Routing</td>
<td>Router</td>
<td>Packets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Path Selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Logical Addressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Data Link</td>
<td>Frames</td>
<td>Bridge Switch</td>
<td>Frames</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Media Access Control (MAC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Physical</td>
<td>Hardware</td>
<td>Transceiver</td>
<td>Bits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electricity Light</td>
<td>Repeater</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radio Waves</td>
<td>Hub</td>
<td></td>
</tr>
</tbody>
</table>

- Class Activity – hands on OSI model drag and drop

Know All These!
Standards Organizations

Other Standards Organizations

- The Electronic Industries Alliance (EIA)
- The Telecommunications Industry Association (TIA)
- The International Telecommunications Union – Telecommunications Standardization Sector (ITU-T)
- The Internet Corporation for Assigned Names and Numbers (ICANN)
- The Internet Assigned Numbers Authority (IANA)
Standards Organizations
Activity - Standards Body Scavenger Hunt

Do activity 3.2.3.7 in class
Reference Models

The Benefits of Using a Layered Model

Protocols: Rules that Govern Communications

- Content Layer
- Where is the café?

Conversation protocol suite
1. Use a common language
2. Wait your turn
3. Signal when finished

- Rules Layer

Physical Layer

Protocol suites are sets of rules that work together to help solve a problem.

3.2.4.1
### Reference Models

**The Benefits of Using a Layered Model**

A networking model is only a representation of a network operation. The model is not the actual network.

<table>
<thead>
<tr>
<th>OSI Model</th>
<th>TCP/IP Protocol Suite</th>
<th>TCP/IP Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>HTTP, DNS, DHCP, FTP</td>
<td>Application</td>
</tr>
<tr>
<td>Presentation</td>
<td>TCP, UDP</td>
<td>Transport</td>
</tr>
<tr>
<td>Session</td>
<td>IPv4, IPv6, ICMPv4, ICMPv6</td>
<td>Internet</td>
</tr>
<tr>
<td>Transport</td>
<td>PPP, Frame Relay, Ethernet</td>
<td>Network Access</td>
</tr>
<tr>
<td>Network</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Link</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Be able to match OSI layers to TCP/IP model layers.
Reference Models

The OSI Reference Model

OSI Model

**Host Layers**
- **data**
  - application
  - Network Process to Application
- **data**
  - presentation
  - Data Representation & Encryption
- **data**
  - session
  - Interhost Communication
- **segments**
  - transport
  - End-to-End Connections and Reliability

**Media Layers**
- **packets**
  - network
  - Path Determination & Logical Addressing (IP)
- **frames**
  - data link
  - Physical Addressing (MAC & LLC)
- **bits**
  - physical
  - Media, Signal and Binary Transmission

Click on buttons 3.2.4.2
Reference Models

The TCP/IP Reference Model
Reference Models
Comparing the OSI and TCP/IP Models

Be able to match OSI layers to TCP/IP model layers
Reference Models
Activity – Identify Layers and Functions

Do the activates on both buttons on 3.2.4.5
Reference Models
Packet Tracer - Investigating the TCP/IP and OSI Models in Action

Do lab
3.2.4.6
For a grade
Data Encapsulation

Communicating the Messages

- Segmenting message benefits
  - Different conversations can be interleaved
  - Increased reliability of network communications

- Segmenting message disadvantage
  - Increased level of complexity
Data Encapsulation

Protocol Data Units (PDUs)

- Data
- Segment
- Packet
- Frame
- Bits

Know PDU for each layer!
Data Encapsulation

Encapsulation

Do animation on 3.3.1.3
Data Encapsulation

De-encapsulation

Do animation on 3.3.1.4
Data Encapsulation
Activity – Identify the PDU Layer

Do Drag and Drop on 3.3.1.5 In class
Moving Data in the Network

Accessing Local Resources

3.3.2.1
Accessing Local Resources

Network Addresses & Data Link addresses

- **Network Address**
  - Source IP address
  - Destination IP address

- **Data Link Address**
  - Source data link address
  - Destination data link address
Accessing Local Resources

Communicating with Device / Same Network

Data Link
Ethernet Frame Header

Source
Network 192.168.1.
Host 110

Destination
Network 192.168.1.
Host 9

Source
Destination

PC1
192.168.1.110
AA-AA-AA-AA-AA-AA

FTP Server
192.168.1.9
CC-CC-CC-CC-CC-CC

3.3.2.2
Accessing Local Resources
MAC and IP Addresses

PC1
192.168.1.110
AA-AA-AA-AA-AA-AA

PC2
192.168.1.111
BB-BB-BB-BB-BB-BB

FTP Server
192.168.1.9
CC-CC-CC-CC-CC-CC

R1
192.168.1.1
11-11-11-11-11-11

Understand ARP protocol!
Do animation on 3.3.2.3
Accessing Remote Resources

Default Gateway

Getting the Pieces to the Correct Network

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network 192.168.1</td>
<td>Device 110</td>
<td></td>
</tr>
<tr>
<td>Device 110</td>
<td>Network 172.16.1</td>
<td></td>
</tr>
<tr>
<td>Device 99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key concept: Default Gateway
Accessing Remote Resources

Communicating Device / Remote Network

<table>
<thead>
<tr>
<th>Data Link</th>
<th>Network Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet Frame Header</td>
<td>IP Packet Header</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Destination</th>
<th>Source</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Network 172.16.1.199</td>
</tr>
</tbody>
</table>

**PC1**
192.168.1.110
AA-AA-AA-AA-AA-AA

**R1**
192.168.1.1
11-11-11-11-11-11

**R2**
172.16.1.99
22-22-22-22-22-22

**Web Server**
172.16.1.99
AB-CD-EF-12-34-56

3.3.3.2
Accessing Remote Resources
Packet Tracer - Explore a Network

Do this one?

Wire shark lab 3.3.3.4
Extra credit?

3.3.3.3 – 3.3.3.4
### Accessing Remote Resources

**Using Wireshark to View Network Traffic**

#### Wireshark Captured Network Traffic

<table>
<thead>
<tr>
<th>No.</th>
<th>Time</th>
<th>Source</th>
<th>Destination</th>
<th>Protocol</th>
<th>Length</th>
<th>Info</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0000000</td>
<td>192.168.0.2</td>
<td>Broadcast</td>
<td>ARP</td>
<td>42</td>
<td>Gratuitous ARP for 192.168.0.2 (C)</td>
</tr>
<tr>
<td>2</td>
<td>0.299139</td>
<td>192.168.0.1</td>
<td>192.168.0.2</td>
<td>NBNS</td>
<td>92</td>
<td>Name query NSTAT *&lt;00&gt;&lt;00&gt;&lt;00&gt;&lt;00&gt; (C)</td>
</tr>
<tr>
<td>3</td>
<td>1.025659</td>
<td>192.168.0.2</td>
<td>192.168.0.1</td>
<td>ICMP</td>
<td>70</td>
<td>Request to Refresh ID (host: pms)</td>
</tr>
<tr>
<td>4</td>
<td>1.043836</td>
<td>192.168.0.2</td>
<td>192.168.0.1</td>
<td>DNS</td>
<td>110</td>
<td>Standard query SRV _ldap._tcp.nbs</td>
</tr>
<tr>
<td>5</td>
<td>1.048652</td>
<td>192.168.0.2</td>
<td>239.255.255.250</td>
<td>SSDP</td>
<td>175</td>
<td>W-SEARCH * HTTP/1.1</td>
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<td>1.050784</td>
<td>192.168.0.2</td>
<td>192.168.0.1</td>
<td>DNS</td>
<td>86</td>
<td>Standard query NDA np10061d.w0004</td>
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<td>192.168.0.2</td>
<td>192.168.0.1</td>
<td>SSSP</td>
<td>337</td>
<td>HTTP/1.1 200 OK</td>
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<td>192.168.0.2</td>
<td>192.168.0.1</td>
<td>DNS</td>
<td>110</td>
<td>Registration NDA np10061d&lt;00&gt;</td>
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<td>1.111945</td>
<td>192.168.0.2</td>
<td>192.168.0.1</td>
<td>DNS</td>
<td>87</td>
<td>Standard query A proxyconf.w0004</td>
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<tr>
<td>10</td>
<td>1.226136</td>
<td>192.168.0.2</td>
<td>192.168.0.1</td>
<td>TCP</td>
<td>62</td>
<td>ncu-2 &gt; http [SYN] Seq=0 Win=6424</td>
</tr>
<tr>
<td>11</td>
<td>1.227282</td>
<td>192.168.0.1</td>
<td>192.168.0.2</td>
<td>TCP</td>
<td>60</td>
<td>http &gt; ncu-2 [SYN, ACK] Seq=0 Ack=1</td>
</tr>
</tbody>
</table>

---

**Frame 11:** 62 bytes on wire (496 bits), 62 bytes captured (496 bits)

- **Ethernet II:** Src: 192.168.0.2 (00:01:05:20:cd:02), Dst: Netgear.2d:75.9a (00:09:5b:2d:75:9a)
- **Internet Protocol:** Src: 192.168.0.2 (192.168.0.2), Dst: 192.168.0.1 (192.168.0.1)
- **Transmission control Protocol:** src Port: ncu-2 (3196), dst Port: http (80), Seq: 0, Len: 0

- **Source port:** ncu-2 (3196)
- **Destination port:** http (80)
- **[Stream index: 5] Sequence number:** 0 (relative sequence number)
- **Header length:** 28 bytes

**Flags:** 0x02 (SYN)

- **Window size value:** 64240

---

File: C:\test.cap 14 KB 00:00:02 120 Packets Displayed 120 Marked Load time: 00:00.000
Network Protocols and Communications

Summary

In this chapter, you learned:

- Data networks are systems of end devices, intermediary devices, and the media connecting the devices. For communication to occur, these devices must know how to communicate.

- These devices must comply with communication rules and protocols. TCP/IP is an example of a protocol suite.

- Most protocols are created by a standards organization such as the IETF or IEEE.

- The most widely-used networking models are the OSI and TCP/IP models.
Summary

In this chapter, you learned:

- Data that passes down the stack of the OSI model is segmented into pieces and encapsulated with addresses and other labels. The process is reversed as the pieces are de-encapsulated and passed up the destination protocol stack.

- The OSI model describes the processes of encoding, formatting, segmenting, and encapsulating data for transmission over the network.

- The TCP/IP protocol suite is an open standard protocol that has been endorsed by the networking industry and ratified, or approved, by a standards organization.
Network Protocols and Communications

Summary

In this chapter, you learned:

- The Internet Protocol Suite is a suite of protocols required for transmitting and receiving information using the Internet.

- Protocol Data Units (PDUs) are named according to the protocols of the TCP/IP suite: data, segment, packet, frame, and bits.

- Applying models allows individuals, companies, and trade associations to analyze current networks and plan the networks of the future.
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Mind Wide Open™