PROTOCOL LAYERING

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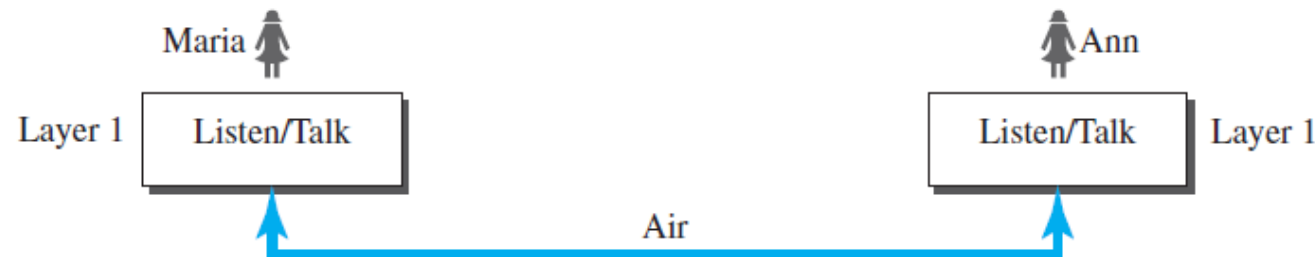
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INTRODUCTION

- In data communication and networking, a protocol defines the rules that both the sender and receiver and all intermediate devices need to follow to be able to communicate effectively.

- When communication is simple, we may need only one simple protocol; when the communication is complex, we may need to divide the task between different layers, in which case we need a protocol at each layer, or protocol layering.

- Modularity in this case means independent layers. A layer (module) can be defined as a black box with inputs and outputs, without concern about how inputs are changed to outputs.

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FIRST SCENARIO

- In the first scenario, communication is so simple that it can occur in only one layer. Assume Maria and Ann are neighbors with a lot of common ideas. Communication between Maria and Ann takes place in one layer, face to face, in the same language.

Figure 2.1 *A single-layer protocol*

Maria

Layer 1 | Listen/Talk

Ann

Listen/Talk | Layer 1

Air

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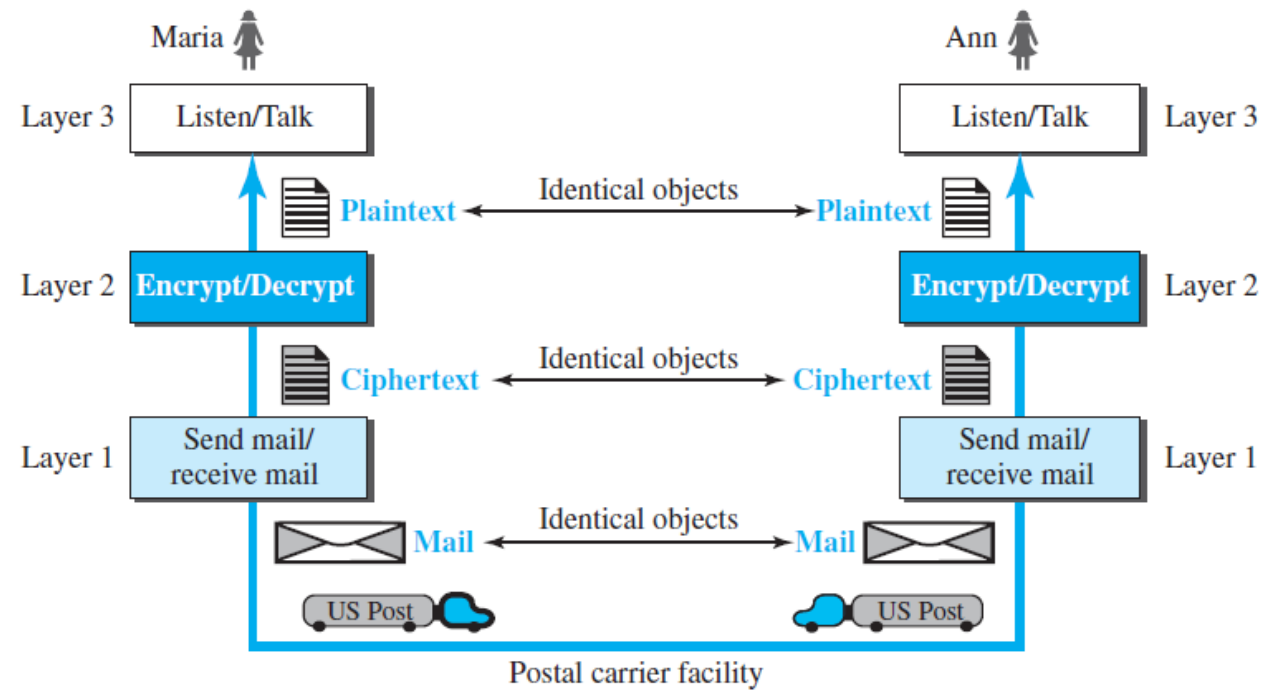
FIRST SCENARIO

- Even in this simple scenario, we can see that a set of rules needs to be followed:

  - First, Maria and Ann know that they should greet each other when they meet.

  - Second, they know that they should confine their vocabulary to the level of their friendship.

  - Third, each party knows that she should refrain from speaking when the other party is speaking.

  - Fourth, each party knows that the conversation should be a dialog, not a monolog: both should have the opportunity to talk about the issue.

  - Fifth, they should exchange some nice words when they leave.

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SECOND SCENARIO

- The two friends want to continue their communication and exchange ideas because they have come up with an innovative project to start a new business when they both retire.

- They decide to continue their conversation using regular mail through the post office. However, they do not want their ideas to be revealed by other people if the letters are intercepted. They agree on an encryption/decryption technique.

- The sender of the letter encrypts it to make it unreadable by an intruder; the receiver of the letter decrypts it to get the original letter.

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SECOND SCENARIO

Figure 2.2 *A three-layer protocol*

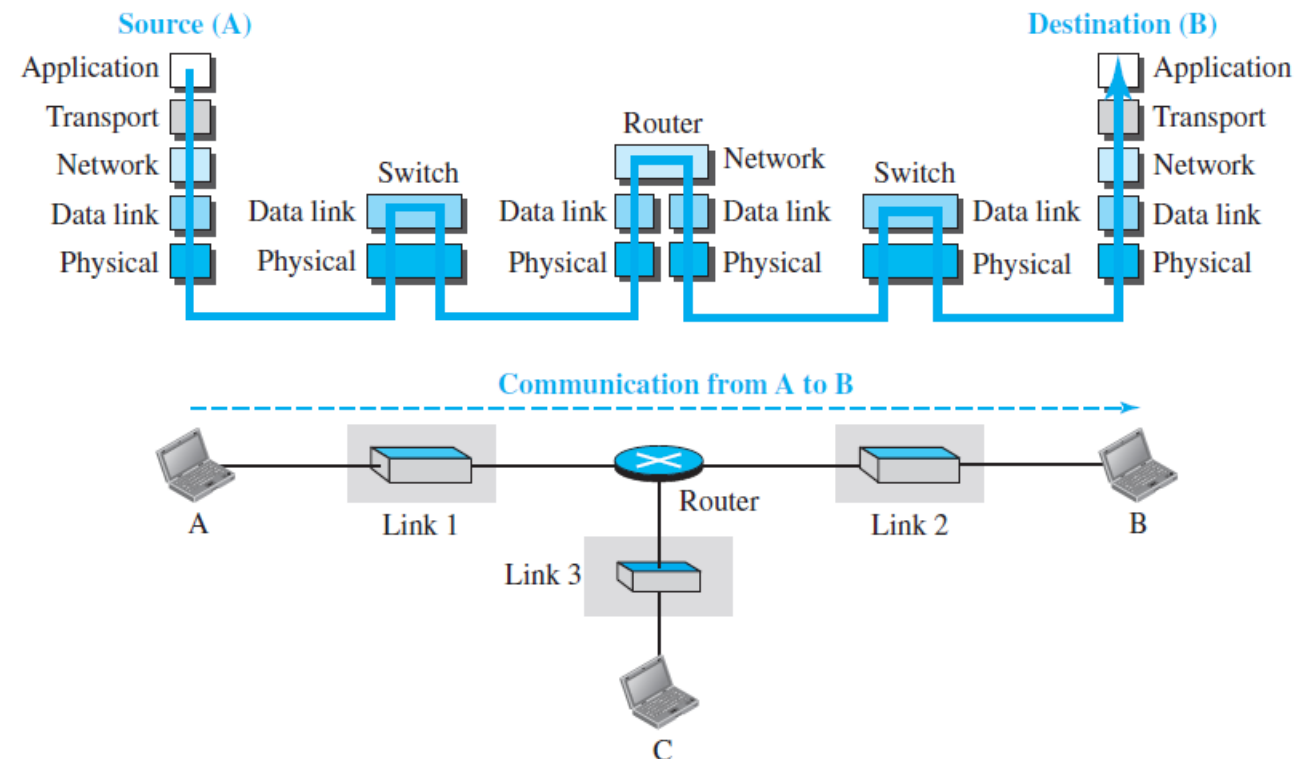Nitesh Kumar Jangid, Assistant Professor, CS, CURAJ

SECOND SCENARIO

- We assume that Ann and Maria each have three machines (or robots) that can perform the task at each layer.

- At Maria's side, the third layer machine listens to what Maria says and creates the plaintext (a letter in English), which is passed to the second layer machine. The second layer machine takes the plaintext, encrypts it, and creates the ciphertext, which is passed to the first layer machine. The first layer machine, presumably a robot, takes the ciphertext, puts it in an envelope, adds the sender and receiver addresses, and mails it.

- At Ann's side, the first layer machine picks up the letter from Ann's mail box, recognizing the letter from Maria by the sender address. The machine takes out the ciphertext from the envelope and delivers it to the second layer machine. The second layer machine decrypts the message, creates the plaintext, and passes the plaintext to the third-layer machine. The third layer machine takes the plaintext and reads it as though Maria is speaking.

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ADVANTAGES

- One of the advantages of protocol layering is that it allows us to separate the services from the implementation. A layer needs to be able to receive a set of services from the lower layer and to give the services to the upper layer; we don't care about how the layer is implemented.

- Another advantage of protocol layering is that communication does not always use only two end systems; there are intermediate systems that need only some layers, but not all layers. If we did not use protocol layering, we would have to make each intermediate system as complex as the end systems, which makes the whole system more expensive.

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TCP/IP LAYERING

Figure 2.5   Communication through an internet

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PRINCIPLES OF PROTOCOL LAYERING

- **First Principle:** The first principle dictates that if we want bidirectional communication, we need to make each layer so that it is able to perform two opposite tasks, one in each direction. For example, the third layer task is to listen (in one direction) and talk (in the other direction). The second layer needs to be able to encrypt and decrypt. The first layer needs to send and receive mail.

- **Second Principle:** The second principle that we need to follow in protocol layering is that the two objects under each layer at both sites should be identical. For example, the object under layer 3 at both sites should be a plaintext letter. The object under layer 2 at both sites should be a ciphertext letter. The object under layer 1 at both sites should be a piece of mail.

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LOGICAL CONNECTIONS

- After following the first and second principles, we can think about the logical connection between each layer as shown in Figure 2.3. This means that we have layer-to-layer communication. Maria and Ann can think that there is a logical (imaginary) connection at each layer through which they can send the object created from that layer.

Figure 2.3 Logical connection between peer layers

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