Computer Network

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1 Basic Terminology

Network, particularly in terms of Computer Science, is consist of several devices that are able to *communicate* with each other. The term *communicate* here means the device within Network can send or receive message from other devices. In order to perform this communication, each device within Network must be able to be located, or simply speaking, each device must have a *address*. There are several methods to assign *addresses* to devices, each of them corresponding to a specific technology that is used to construct Network. One popular technology is *Internet*, which assign a *IP* to each device within Network as their address. In here, *Internet* is the technology that used to construct Network and *IP* is the method that Internet used to address(locate) devices within it.

Furthermore, in order to let devices within Network communicate with each other, one essential requirement is that there must be a thing that can carry the message and deliver it between devices. Such thing, which can be called as *media*, consist the *Physical Layer* of Computer Network

2 Physical Layer

As described in last section, *Physical Layer* is consist of the media that can carry and deliver messages. Particularly, as Figure 1 illustrated, the media is the line that connect Device A and B. Furthermore, based on the

Figure 1: Media between Different Devices

characteristics of the media, it can be categorized into following three classes::

1. **Simplex**: This type of media can only transport message with a *fixed direction*, *e.g.* from Device A to Device B.
2. **Half-Duplex**: This type of media can transport message with both directions. However, it can only choose one direction during each transportation, *e.g.* from A to B or B to A.
3. **Duplex**: This type of media can transport message with both direction during a transportation, *e.g.* transport message from A to B and B to A in the same time.

Indeed, the Figure 1 give us an inspiration about how to construct a simple network, which is connecting each devices within network with a media. For example. assume we want to construct a Network contain four devices, the easiest way to do this is shown in Figure 2, in which, each device is connected with the rest.

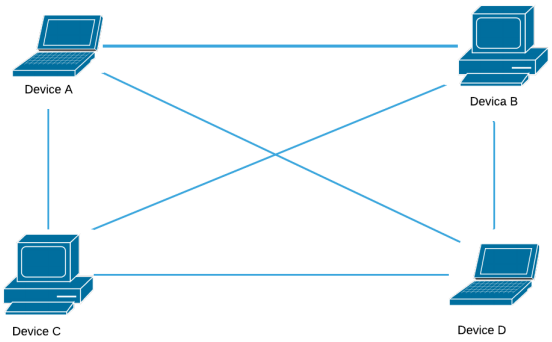

Figure 2: Basic Topology

However, the problem of this topology is that the number of medias will grow exponentially with the increasing number of devices. Therefore, an improvement topology along with an algorithm(protocol) to control how the messages are delivered is required, which relate to our next topic: *Data-Link Layer*

3 Data-Link Layer

The solution of the problem remaining in last section is straightforward: By adding one or more *Switch* which depend on the number of devices within network. The Switches work as bridges that connect different devices in Network, as illustrated in Figure 3:

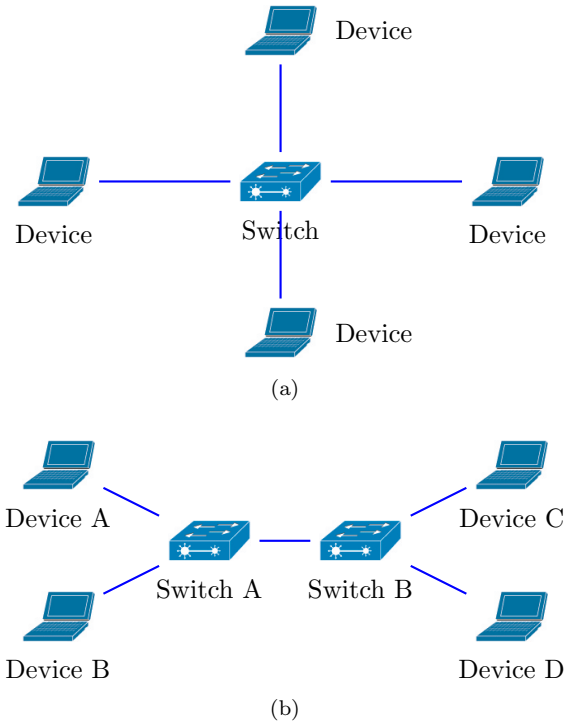

Figure 3: Two Example of Network Topology

Even though the switches reduce the number of connection, the new problem is how the the different devices communicate with each other under the condition that they are not direct connected. This problem may be better illustrated by an example: Assume Device A in Figure 3b is willing to send a message to Device D. The first thing Device A need to do is locating Device D, or we can say, Device A need to find the *address* of Device D. The address here is called *MAC address* and in order to find Device B's MAC address, Device A will *broadcast* a request message which contain a query: "What is the MAC address of Device B" and it's own MAC address. The *broadcast* here means A will send this query to all the devices within this Network(Device B, C and D). In order to indicate this query is a broadcasting message, Device A will set the destination MAC address of this query as a special value: FF-FF-FF-FF-FF-FF and send it to Switch A. When Switch A receives

this query and recognizes this message is a broadcasting message as it has FF-FF-FF-FF-FF-FF as destination MAC address, Switch A will send this query to every device it connect to, include both Device B and Switch B. Furthermore, when Switch A receive this query, it will record the source MAC address of this query(Device A's MAC address) along with the index of port that receive this query into a table, *e,g* Switch A will record the pair:

Device A's MAC address	Port 5

into the table if the query message come through port 5 of Switch A. This table is called *ARP table*. By maintain such a table, when Switch A receive a message which has Device A's MAC address as destination, it can directly forward this message to Device A through port 5 by searching Device A's MAC address along with the corresponding port within ARP table. After Switch A broadcast the query, Switch B and Device B will both receive this query message. Device B will realize that Device A did not ask its' MAC address and will simply discard this query message without further action. By contrast, Switch B will keep this broadcasting which finally cause Device D receive this query. One thing that need to be noticed is that Switch B will also record Device A's MAC address and the corresponding port index into ARP table by reading the source MAC address within query message. When Device D receive this query, it will response Device A with a respond message which use Device A's MAC address as destination address, its' own MAC address as source address and carry its' MAC address as query result. This respond message will be transferred back to Device A through Switched with the Device D's MAC address(source address) be recorded into each Switch's ARP table. After Device A receive the MAC address of Device D, it can then send the further message by setting Device D's MAC address as destination address. The Switch can also know which port should be used to send these messages by searching the ARP table to find Device D's MAC address.

It can be seen from the above procedure, in order to perform message delivering within this Network topology. The messages must have some specific content, *e.g.* source address and destination address, or without loss generality, we can say, the messages that being transferred under this mechanism must have s specific format. This message delivering mechanism with specific message format is called *protocol* and the message delivering mechanism within the Network topology described above is called *ARP Protocol*.