

Functions of Multiplexers in a Data Communication Network

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## Introduction

This paper analyzes multiplexer functions. The paper discusses its functions, forms, and Open Systems Interconnection (OSI) levels involved. The positioning of multiplexer in a network and selection of multiplexers are also discussed.

## Functions of multiplexers

In large-scale systems, it is often required to carry two or more signals in a single line. There can be only one signal per line. Hence, the requirement is achieved by selecting different signals at different instants. Multiplexers are used to take  $n$  input lines and provide input to one output line. The primary benefit of multiplexer is the reduction in network costs by minimizing the communication links between two points. Other benefits include the capability to do data transmission, capability to do error detection, and the capability to manage transmission resources. Multiplexers increase the ability of the network to handle the data within a certain amount of bandwidth and time. Multiplexing can be performed on analog as well as digital signals. In the case of analog signals, it is achieved through the division of frequency and wave. In the case of digital signals, it is achieved through time division. Time division multiplexing can be synchronous or asynchronous. The equipment used for multiplexing is called Multiplexer (MUX). MUX is placed in the communication link at the transmitting end. Demultiplexer (DEMUX) separates the composite signal at the receiving end (Dueck & Reid, 2011). Multiplexer and demultiplexer may be combined to form a single equipment. Inverse multiplexing produces the opposite effect. It breaks one data stream into several data streams.

Multiplexers can be used in various fields where the requirement is to transmit multiple data using a single line. Some of the applications of multiplexers include communication system,

telephone network, computer memory, and transmitting data signals from the computer system of a satellite. In a communication system, multiplexing may assist in transmitting video and audio data simultaneously using a single transmission line. In telephone network, multiple audio signals may be transmitted using a single line. In the computer memory, multiplexers reduce the number of copper lines that are required for connecting the memory to other parts of the computer circuit.

### **Forms of multiplexers**

The process of multiplexing can be implemented using four methods; Frequency Division Multiplexing (FDM), Time Division Multiplexing (TDM), Statistical Packet Multiplexing (SPM), and Fast Packet Multiplexing (FPM).

#### **Frequency Division Multiplexing (FDM)**

When the signal is analog, multiplexing is usually achieved through Frequency Division Multiplexing (FDM). It divides the carrier bandwidth into subchannels. The subchannels have different frequency widths. Each subchannel carries a signal in parallel at the same time (Hamad, 2011). An example of FDM is cable television. The method assigns a different frequency to each TV channel.

#### **Time Division Multiplexing (TDM)**

When the signal is digital, multiplexing is commonly achieved through Time Division Multiplexing (TDM). In this method, same channel carries multiple signals. The signals are available in the channel in alternating time slots (Iyengar & Brooks, 2012).

### **Statistical Packet Multiplexing (SPM)**

In this method, active input channels receive bandwidth through dynamic allocation. The dynamic allocation provides an efficient utilization of bandwidth. An idle channel, in this process, does not receive any time allocation. Errors from incoming packets are detected and corrected using a store-and-forward mechanism (Peterson & Davie, 2011).

### **Fast Packet Multiplexing (FPM)**

This method is similar in approach to SPM. For any input needed, the method can assign maximum bandwidth. The difference is that the method does not use store-and-forward mechanism. Due to the absence of this mechanism, error detection and correction cannot be performed.

### **OSI levels involved**

In the transport layer of the OSI model, data communication between devices is managed through flow control. It ensures that the data sent by the transmitting device does not exceed the data that can be processed by the receiving device. In this connection, the role of multiplexing is transporting data from several applications to a single line. The transport layer establishes, terminates, and maintains virtual circuits.

Multiplexer is the device of a physical layer. Its function is to combine multiple data streams. The technique of multiplexing can be extended to a channel access or multiple access method. For example, statistical multiplexing can be extended to carrier sense multiple access (CSMA). Similarly, time division multiplexing can be extended to time division multiple access

(TDMA) (Bouchet, 2013). When multiple access methods are used, media access control protocol is also involved. The protocol is part of the data link layer. Hence, data link layer of OSI is also involved, when multiplexing uses multiple access method.

### **Multiplexer in a network**

Multiplexers can either be digital circuits or analog types. Digital circuits are made from high-speed logic gates. They are used for switching binary data. Analog types use transistors or relays for switching the current or voltage inputs to a single output. The basic multiplexer comprises of multiple data inputs, data selection switch, and single data output. In a simple 2-1 line multiplexer circuit, the input A controls which of the input  $I_0$  or  $I_1$  will pass to the output at Q. The truth table of the logic is shown below:

Inputs			Output
A	$I_1$	$I_0$	Q
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

**Table 1: Truth Table of 2-1 line multiplexer**

**Source: (Sinclair, 2011)**

Table 1 shows that input  $I_1$  or  $I_0$  is selected based on the data select input A. If A is low or 0,  $I_1$  passes its data to the output Q.  $I_0$  is blocked in this case. If A is high or 1,  $I_0$  passes its data to the output Q.  $I_1$  is blocked in this case.

Multiplexers may also take the form of the components of programmable logic devices. A custom logic circuit can be developed by making input signals to follow the logic arrangement. In such cases, selector inputs serve as the logic inputs. The arrangement is useful when cost factor is very crucial. The arrangement is also applied for modularity.

### **Choosing a multiplexer**

Multiplexers are used in various devices for data communication. They are usually used in conjunction with demultiplexers. Equipment where multiplexer may be used includes graphics controllers, digital semiconductors, and central processing units. Different types of multiplexers are available depending on the need of the buyer. In the selection of the right multiplexer, the key considerations include the number of concurrent connections, media access control, and the number of ports. Other considerations include the data rate and the operating temperature. Multiplexers have to handle many signals; hence the efficiency is very important. The rating for efficiency needs to be evaluated as to whether it is the assessment of the manufacturer or the reflection of the actual performance of the multiplexer. Independent efficiency tests can provide a clear picture in this respect. The accommodating nature of multiplexer is also important keeping in view the changes in data flow. There are certain additional features that prove useful in multiplexers. These include full duplexing and IP addressing. Selection of a proper interface is also crucial for a multiplexer. Most of the multiplexers are designed for placing in computer

rooms. The key features to look for in the multiplexers are their types, inputs, and formats.

Multiplexers are provided as simplex or duplex type.

### **Conclusion**

Multiplexers receive multiple inputs and provide one output. They reduce costs in a data communication network by reducing the communication links between two points. Multiplexing can be accomplished using frequency division, time division, statistical packet, and fast packet. In the transport layer of the OSI model, the role of multiplexing is transporting data from several applications to a single line. Multiplexer is the device of a physical layer. In the case of multiple access methods, data link layer of OSI model is also involved. The basic multiplexer has multiple data inputs, data selection switch, and single data output. Truth table of 2-1 line multiplexer processes one input when the data select input is low, and another input when the data select input is high. For a selection of multiplexer, critical considerations include the number of concurrent connections, media access control, number of ports, data rate, and operating temperature. Independent efficiency tests provide a clear picture of the performance of the multiplexers.

## References

Bouchet, O. (2013). Wireless Optical Telecommunications. *John Wiley & Sons*. Retrieved from  
<http://books.google.com/books?isbn=1118562712>

Dueck, R., & Reid, K. (2011). Digital Electronics. *Cengage Learning*. Retrieved from  
<http://books.google.com/books?isbn=1439060002>

Hamad, O. F. (2011). Analog, Digital and Multimedia Telecommunications: Basic and Classic Principles. *Xlibris Corporation*. Retrieved from  
<http://books.google.com/books?isbn=1456810219>

Iyengar, S. S., & Brooks, R. R. (2012). Distributed Sensor Networks: Sensor Networking and Applications. *CRC press*. Retrieved from  
<http://books.google.com/books?isbn=1439862877>

Peterson, L. L., & Davie, B. S. (2011). Computer Networks: A Systems Approach. *Elsevier*. Retrieved from <http://books.google.com/books?isbn=0123850606>

Sinclair, I. (2011). Electronics simplified. *Newnes*. Retrieved from  
<http://books.google.com/books?isbn=008097063X>