UNIT 12 COMMUNICATION AND CONTROL

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12.1 INTRODUCTION

In order for a computer or controller to be useful in automating a manufacturing system, it must be able to communicate with external devices. These external devices may be sensors for monitoring a process, actuators for controlling a process, or the external device may be another computer. Information exchanges between devices require the standardization of the language of communication. A brief discussion of different network architecture, several LAN standards, tools for object identification like sensors, barcodes, transponders, and vision systems are provided in coming sections. Control of communication system, and data base management system in CIM is also discussed in brief.

Objectives

After studying this unit, you should be able to

- describe communication and control,
- define local area network,
- explain network protocols,
- identify types of manufacturing sensors, and
- understand manufacturing database management.

12.2 LAN STANDARDS

Local Area networks, generally called LAN, are privately owned networks within a single building or campus of up to a few kilometers in size. They are primarily used to connect personal computers and workstations in company offices and factories to share resources and exchange information. In recent years, LAN techniques have become an efficient method of data transfer in both shop floor and office automation. It can provide
a faster communication than point-to-point communication method. It enables many-to-many communication on the same network through the same cable. An ideal LAN has the following characteristics:

- High speed: greater than 10 Mbps (Mega Bytes Per Second)
- Low cost: easily affordable on a microcomputer and/or machine controller.
- High reliability/integrity: low error rates, fault-tolerant, reliable
- Expandability: easily expandable
- Installation flexibility: easy installation in an existing environment
- Interface standard: standard interface across a range of computers and controllers

A LAN comprises software that controls data handling and error recovery, hardware that generates and receives signals, and media that carry the signal. To ensure a proper communication between different devices, a set of rules called protocol must be followed. This protocol governs the software and hardware design by defining the logical, electrical, and physical specification of network. Different LANs are distinguished by three characteristics:

(i) Their size
(ii) Their transmission technology
(iii) Their topology

IEEE has produced several standards for LAN, collectively known as IEEE 802. It includes CSMA/CD (carrier sense multiple access with collision detection), token bus, and token ring. The various standards differ at the physical layer and MAC (Multiple Access Control) sublayer but are compatible at the data link layer. The IEEE 802 standards have been adopted by ANSI as American National Standards, by NIST as government standards, and by ISO as international standards (known as ISO 8802). The standards are divided into different parts: 802.1 standard provides an overview of the definitions and standards of interface primitives, 802.2 describes the upper part of the data link layer, which uses the LLC (logical link control) protocol, parts 802.3 through 802.5 describes the three LAN standards, the CSMA/CD, token bus, and token ring standards respectively. Each standard covers the physical layer and the MAC sub layer protocol. Additional information can be found in Stallings, 1993b.

In following sections, the three sections have been described separately.

**IEEE Standard 802.3 (CSMA/CD)**

The IEEE 802.3 standard is for a CSMA/CD (carrier sense multiple access with collision detection) LAN. When a station wants to transmit, it links to the cable. If the cable is busy, the station waits until it goes idle; otherwise it transmits immediately. If two or more stations simultaneously begin transmitting on an idle cable, they will collide. All colliding stations then terminate their transmission, wait a random time, and repeat the whole process all over again.

**IEEE Standard 802.4 (Token Bus)**

This standard, 802.4, describes a LAN called a Token Bus LAN. Physically, the token bus is a linear or tree-shaped cable onto which the stations are attached. Logically, the stations are organized into a ring, with each station knowing the address of the station to its “left” and “right” as shown in Figure 12.1. When the logical ring is initialized, the highest numbered station may send the first frame. After it is done, it passes permission to its immediate neighbour by sending a special control frame called a token. The token propagates around the logical ring,
with only the token holder being permitted to transmit frames. Since only one station at a time holds the token, collision do not occur.

**IEEE Standard 802.5 (Token Ring)**

The IEEE802.5 standard stands for *Token Ring LAN*. A ring really consists of a collection of a ring interfaces connected by point-to-point lines. Each bit arriving at an interface is copied into a 1-bit buffer and then copied out onto the ring again. While in the buffer, the bit can be inspected and possibly modified before being discarded. This copying step introduces a 1-bit delay at each interface. In a token ring a special bit pattern, called the token, circulates around the ring whenever all stations are idle. When a station wants to transmit a frame, it is required to seize a token and remove it from the ring before transmitting. This action is done by inverting a single bit in the 3-bytes token, which instantly changes it into the first 3 bytes of a normal data frame. Because there is only one token, only one station can transmit at a given instant, thus solving the channel access problem the same way as the token bus solves it. A ring and its interfaces are shown in Figure 12.2.

**SAQ 1**

Discuss the following:

- LAN
- CSMA/CD
- Token Bus and Token Ring
Network Architecture

A communication network consists of a number of components such as hardware, software, and media. A network architecture describes the components, the functions performed, and the interfaces and interactions between the components of a network. It encompasses hardware, software, standards, data link controls, topologies, and protocols. It defines the function, and interactions among three types of components.

- Network hardware, components such as cables, modems, communications controllers, and adapter cards.
- Communication software modules, which establish and monitor sessions between remotely located processes, and allow exchange of data and control messages.
- Application programs (user processes) that uses the networks.

Protocols

Protocols in the network system are a set of instructions to exchange the information between two devices. A protocol specifies the message format and the rules for interpreting and reacting to messages.

The open system interconnection (OSI) reference model proposed by the International Standards Organization (ISO) incorporates a framework for modeling communication protocols. This model encompasses interoperability between dissimilar systems. The whole communication process is divided into several layers by ISO/OSI as shown in Figure 12.3; the physical layer, the data layer, the network layer, the transport layer, the session layer, the presentation layer and the application layer.

The lower four layers are responsible for the transfer of information between applications. The upper three layers support the applications. Standards are set for each layer to handle communication from one device to another. A brief discussion of the functions of these layers is as follows.

![Figure 12.3: Communication Layers](image-url)
The Physical Layer

It consists of the hardware that drives the network and circuits and specifies the type of cable that is used. It deals with mechanical, electrical, functional, and procedural characteristics to access the physical bits and are passed from one device to another.

The Data Link Layer

It performs the task of transferring information across the physical link by sending blocks of data (frames) with necessary synchronization, error control, and flow control functions. It is used to improve the error frequency for messages moved between adjacent nodes. The data integrity transmitted between two devices in the same network is ensured on this layer. The ISO HDLC (high-level data-link control) standard is used in this layer. The HDLC standard starts and terminates with an 8-bit flag frame.

The Network Layer

It uses to select the outgoing line to send the message to a node. Since it knows the physical connections and paths between the transport entities in a session, it relieves the transport layer of the need to know anything about the underlying network technologies used to connect end systems.

The Transport Layer

It ensures the transparent transfer of packets (data), to and from the session layer without disruption. This layer has three major functions; to establish a proper connection and quality (speed), to initiate the data transfer and manage the data to be sent, and to release the connection.

The Session Layer

It controls the communication between applications by establishing, managing, and terminating virtual connections between cooperating applications.

The Presentation Layer

It decodes the data to match the device and requirements. It makes the application process independent of differences in data representation.

The Application Layer

It provides the user interfaces to the networking system. The services provided by this layer include terminal emulation, file transfer, electronic mail, and distributed database managers.

Based on this OSI reference model, a number of protocols have been developed. Examples include MAP/TOP, TCP/IP, SNA from IBM, DECNET from DEC and many others. A brief discussion of the above mentioned protocols, MAP/TOP and TCP/IP has been given in following two sections.

12.3.1 MAP and TOP

The manufacturing automation protocol (MAP) was developed by General Motors to meet its manufacturing integration needs. Sometimes the networks for different products of the same vendors are not always compatible. To connect these products directly in a communication network becomes a seemingly impossible task. On the other hand, to implement a computer-integrated system, it is required to have communication between different factory devices such as NC machines, robots, cell controllers, and area controllers. MAP supports application-layer protocols such as manufacturing messaging specifications (MMS), intended for real time communication between such devices. The different layered approach of MAP, as shown in the Table 12.1, allows new technology to be incorporated when it becomes available. It uses the ISO reference model and coordinates with the Technical and Office Protocol (TOP) developed by Boeing Company for office communications, and other standards. TOP and MAP share the
standards on several layers. The difference is on the physical layer, where TOP is based on the CSMA/CD bus of Ethernet. A gateway can easily be built to bridge the two networks. With MAP and TOP, not only communication within a manufacturing shop can be ensured, but also a link to the corporation office can be established.

Table 12.1 describes the MAP and TOP specifications as prescribed by IEEE.

<table>
<thead>
<tr>
<th>Layer</th>
<th>MAP Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer 7</td>
<td>ISO FTAM (DP) 8571</td>
</tr>
<tr>
<td></td>
<td>File Transfer Protocol (FTP)</td>
</tr>
<tr>
<td></td>
<td>Manufacturing Messaging Format Standard (MMFS)</td>
</tr>
<tr>
<td></td>
<td>MAP Directory Services</td>
</tr>
<tr>
<td></td>
<td>MAP Network Management</td>
</tr>
<tr>
<td>Layer 6</td>
<td>NULL / MAP transfer</td>
</tr>
<tr>
<td>Layer 5</td>
<td>ISO Session (IS) 8327</td>
</tr>
<tr>
<td></td>
<td>Basic Combined Subset &amp; Session Kernel, Full Duplex</td>
</tr>
<tr>
<td>Layer 4</td>
<td>ISO Transport (IS) 8073</td>
</tr>
<tr>
<td></td>
<td>Class 4</td>
</tr>
<tr>
<td>Layer 3</td>
<td>ISO Internet (DIS) 8473</td>
</tr>
<tr>
<td></td>
<td>Connectionless, Sub Network Dependent Convergence Protocol</td>
</tr>
<tr>
<td>Layer 2</td>
<td>ISO Logical Link Control (DIS) 8802/2 (IEEE 802.2)</td>
</tr>
<tr>
<td></td>
<td>Type 1, Class 1</td>
</tr>
<tr>
<td></td>
<td>ISO / IEEE 802.4 Token Passing Bus Medium Access Control</td>
</tr>
<tr>
<td>Layer 1</td>
<td>ISO Token Passing Bus (DIS) 8802/4 (IEEE 802.4)</td>
</tr>
<tr>
<td></td>
<td>10 Mbps Broadband</td>
</tr>
</tbody>
</table>

### 12.3.2 TCP/IP and Protocol Suite

The transmission control protocol/Internet protocol (TCP/IP) was developed by the Defense Advanced Research Project Agency (DARPA) in the early 1970s to interconnect computers in the Advanced Research Projects Agency Network (ARPANET). The TCP/IP consists of several major protocols, such as Internet protocol; transmission control protocol, Telnet, file transfer protocol (FTP), and simple mail transfer protocol (SMTP). It is compatible with working on a wide range of computing systems, such as mainframes, minicomputers, and microcomputers. It can be used to transfer files between heterogeneous systems such as SUN, DEC, IBM, Macintosh, and many other computers. It is supported by all Unix vendors and included in software packages by the SUN Microsystems Unix operating system. Based on TCP/IP, a number of application protocols have been developed, which includes Telnet, FTP, network file system (NFS), simple mail transfer protocol (SMTP), and simplified network management protocol (SNMP).

To establish communication between two hosts, first, a socket (end point of communication) is created by a system call with a specification of destination. It uses an associated data structure that stores all the necessary information for the communication and a data buffer. Each data is broken into small pieces and sent to the socket with an assigned protocol. The TCP, IP, and Ethernet headers are added to the packet before it gets transferred to the Ethernet cable. The TCP header comprises source port, destination port, sequence number, acknowledgement number, checksum, urgent pointer, and additional flags. The IP header includes type of service total message length, ID, fragment flags, header checksum, protocol, source and destination address, and so on.
The header information is stripped off the data packet from the destination host and proper action is being taken to ensure the correct data transfer. When using an application such as FTP or TELNET, the user only need specify the destination host name.

For example to access the website of IGNOU one would type ignou.ac.in.

**SAQ 2**

Discuss the following:

- OSI 7 level reference model
- MAP
- TOP
- TCP/IP
- Physical layer and network layer

## 12.4 SENSORS

Sensors are termed as the eyes and ears of control system. The main uses of sensor are to provide real time information for directly controlling process as well as provide information for data logging purposes. For example, a sensor can be used to provide a count of the daily unit produced off a particular manufacturing line. Sensor technology finds a great use in the field of CIM, laboratory testing, process control, and other areas commercially available. As shown in Figure 12.4, sensors can be categorized in two types: Discrete and Continuous. A discrete event sensor or on/off sensor provides the state based on the occurrence of some external event. The event may be passing of a part by a point along a conveyor or the movement of a mechanical device beyond some prescribed limit. The discrete event sensors only give the knowledge of two states based on the condition being sensed. In the first example, the part is either present or not present. In second case, the device is either within the prescribed limit or it is not.

**Discrete event** sensors used in the manufacturing are typically based on either mechanical, electrical, or optical technology.

A continuous sensor measures the magnitude of an attribute of interest of the physical process that is being monitored. These sensors can be used in measuring the temperature of heat-treating process, the pH in a chemical process, or the speed of a conveyor line. They provide the information over a continuous range of operation of the process and they are commonly used in continuous control applications, where the process is being regulated based on continuously sensed attribute data.

![Figure 12.4 : A Classification of Sensor Types](image-url)
12.4.1 Discrete Event Sensors

Some of the common discrete event sensors used in manufacturing are mechanical limit switches, proximity sensors and photoelectric sensors.

Mechanical Limit Switches

Mechanical limit switches comprises a mounted actuator arm that operates a set of electrical contacts when the arm is placed. The electric contact may either be closed or open initially and the action of the actuator and lever arms takes it from its normal, or deactivated, state to the other state. Limit switches come in several varieties and designs. They are designed for heavy-duty application in which there is physical contact between the actuator and the process being sensed. For example, limit switches are often used on machine tools to limit the travel of a machine axis. They are sometimes used in material handling application. They are designed to handle relatively high voltages, both AC and DC.

Proximity Switches

Proximity switches refer to a non-contact sensor that works on the principle of a magnetic field. The proximity switches most commonly used in the manufacturing environment are the inductive proximity switch and the capacitive proximity switch. Proximity switches have relatively short sensing ranges typically from 1 to 60 mm; therefore, they must be used in situations where the target is allowed to come close to the sensor.

Photoelectric Sensors

Photoelectric sensors are non-contact devices that output a signal in response to the interruption of a light beam. The two main components are the emitter and the receiver. The light source is a light emitting diode (LED). A photoelectric sensor system comes with an oscillator that modulates, or pulses, the LED on and off at very high frequencies. They are designed for use in four basic sensing modes: opposed, retro reflective, diffuse, and convergent. The appropriate sensing mode depends on the application. Photoelectric sensors have the capability of being used over a fairly long distance. For example, distances over 100 feet are possible in an opposed sensing modes.

Fluid Flow Switches

This device is analogous to a limit switch in mechanical systems. They are employed in process industries as a device to detect when a fluid travelling in a pipe is over a specified volumetric flow rate. Such a sensor can be used to govern the speed of an upstream pump, reducing it when the flow is too fast.

12.4.2 Continuous Sensors

Continuous sensor is a device that converts one measured physical quantity into another that is proportional to the measured physical quantity. The measured physical quantity might be position, velocity or temperature; the converted proportional physical quantity is typically one that can be used in an electronic circuit, such as electrical resistance. The concept of closed loop continuous control is illustrated in Figure 12.5. The components of a sensing system and their relationship to a digital controller are shown in Figure 12.6. The controller, a digital device, requires that the information provided by the sensor be converted to digital from before it can be acquired and recorded by the processor of the controller. The device that performs this conversion is an analog to digital (A/D) converter. Similarly, to map out a relation between a digital output of the controller and an analog output, digital to (analog D/A) converter is used.
SAQ 3

(a) What is sensor? What are the two types of sensors and how they differ from each other?

(b) What are the different types of discrete event sensors?

(c) What are the different components of a sensing system?

12.5 BAR CODES AND TRANSPONDERS

Bar Codes

Bar code technology has become the most popular method of automatic identification in retail sales and in factory data collection. A typical bar code
comprises a sequence of thick and narrow colored bars separated by thick and narrow spaces separating the bars. The pattern of bars and spaces is coded to represent alphanumeric characters. Bar code readers interpret the code by scanning and decoding the sequence of bars. The reader consists of the scanner and decoder. The scanner emits a beam of light that is swept past the bar code either by manually or automatically and senses light reflections to distinguish between bars and spaces. The light reflections are sensed by a photo decoder that converts the spaces into an electrical signal and the bars into absence of an electrical signal. The width of the bars and spaces is indicated by the duration of the corresponding signals. The decoder analyzes the pulse train to validate and interpret data.

**Bar Code Symbol**

The Universal Product Code is only one of many bar code formats in commercial use today. The bar code standard adopted by the automotive industry, the department of defense, the General Services Administration, and many other manufacturing industries is Code 39, also known as AIM USD-2 (Automatic Identification Manufacturers Uniform Symbol Description-2). Code 39 uses a uniquely defined series of wide and narrow elements (bars and spaces) to represent 0-9, the 26 alpha characters, and special symbol. The wide elements are equivalent to binary value of one and the narrow elements are equal to zero. The width of the narrow bars and spaces, called the **X dimension**, provides the basis for a scheme of classifying bar codes into three code densities:

- **High density**: X dimension is 0.010 inch or less
- **Medium density**: X dimension is between 0.010 and 0.030 inch
- **Low density**: X dimension is 0.030 inch or greater.

**Bar Code Readers**

They are classified as contact or non-contact readers. Some require a human being to operate them and others are stand-alone automatic units. **Contact bar code reader** are hand held wands or light pens operated by moving the tip of the wand quickly past the bar code on the object or document. **Noncontact bar code readers** do not use a contacting wand to read the bar code. They focus a light beam on the bar code and a photo detector reads the reflected signal to interpret the code. The reader probe is located at certain distance from the bar code during the reading process.

**Bar Code Printers**

Preprinted bar codes are produced using traditional techniques such as letterpress and flexographic printing. These methods are used for printing labels in large quantities for product cartoons. A relatively new technology for bar code making of metal parts in a factory makes use of a laser etching process. The process provides a permanent identification mark on the item, which is not susceptible to damage in the harsh environments that are encountered in many manufacturing processes.

**Transponders**

A transponder is another smart device of object identification. A transponder is an instrument anchored to any device, which receives an acoustic signal at a certain frequency (frequency is number of wavelengths that pass a fixed point per second) and transmits a response at a different frequency. In the illustration in Figure 12.7, transponders are anchored along the top of the ridge and spaced at even intervals.
Financial management


Figure 12.7 : Transponders

Basically, transponder is a device that works on the RF (Radio frequency) principle. The chip used in such device can handle hundreds of bytes of information. A radio signal at specific assembly stations causes the transponders to emit information that can be decoded by a local receiver. Some smart transponders have read/write capacity, allowing user to support decision-making. But cost incurred while using transponders is very high, thus its uses are restricted in shipping industry, space works, etc.

SAQ 4

Discuss the following: Barcode, Barcode Reader, Barcode Printer, Transponders.

12.6 VISION SYSTEM

When a part arrives at a facility first of all it has to be identified. This may be done by visual or automatic inspection. For visual inspection, the name of the part and the number of items delivered are recorded via a computer terminal and sent to the central computer to be stored in a data bank. Automatic identification is possible using a vision system or a code reader. With automated manufacturing, it becomes necessary to track a workpiece from the start of production to its final assembly. A vision system can be interfaced with a robot to track a workpiece in a better manner. The main functions of a typical vision system are to locate the part, identify it, direct the gripper to a suitable grasping position, pick up the part, and bring it to the work area. It can be applied in a number of areas, like assisting a robot in an assembly to perform quality control tasks and defect recognition, to lead a product through a material flow system, to carry out measurements of inaccessible fast-moving parts, to adjust tools on machines, and to recognize printing errors in a printing shop. The main functions of a vision system are:

(i) Identification
(ii) Determination of position and angular orientation in relation to reference coordinates
(iii) Positioning, fitting, and sorting
(iv) Setup or adjustment of tools
(v) Measurements of distances, and angles
(vi) Extraction and identification of specific parameters
(vii) Visual testing for errors and completeness

Most vision system has three features that facilitate the integration with a robot programming system:

(i) Parts to be recognized are described by user-defined symbolic names that are represented by ASCII strings.
Position and orientation of the workpiece are determined relative to a Cartesian coordinate system.

Parts to be recognized are taught to the system by “showing”. The symbolic name is also entered.

Some of the models of vision system include:

(i) Linear vision system to measure distance.

(ii) Camera system to recognize workpieces, their locations, and their orientation.

(iii) Elementary Photoelectric vision system

(iv) Picture recognition sensors

(v) Self-Scanning Photo arrays

**SAQ 5**

(a) What are vision systems? What is the advantage of using a vision system?

(b) What are the main functions of a vision system?

(c) Give some examples of vision system?

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**12.7 COMMUNICATION SYSTEM**

In order for a computer or controller to be useful in automating a manufacturing system, it must be able to communicate with external devices. These external devices may be sensors for monitoring a process, actuators for controlling a process, or the external device may be another computer. Information exchanges between devices require the standardization of the language of communication. The American Standard Code for Information Exchange (ASCII) is such a language and it is used by most computer manufacturers. The ASCII code defines the relationship between alphabetic, numeric, and punctuation characters and their corresponding binary string. ASCII provides binary symbols as well for control actions, such as carriage returns (CR) and the *line feed (LF)*. There are basically two primary techniques of data transfer used in computer interfacing: *programmed data transfer and direct memory access (DMA)*. Each technique utilizes a different set of hardware and software protocols. There are two primary methods of transferring binary data – parallel and serial data transmission. Parallel data communications allows several bits to be transferred simultaneously across the interface between communication devices, while serial data communication, as the name implies, transmits data one bit at a time.

A communication system consist of several LANs for networking, certain specified protocols, database management system etc.

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**12.8 MANUFACTURING DATA BASE MANAGEMENT**

Data base management is an important consideration because of the large amount of data associated with the concept of a one-part model and configuration management. In an engineering/manufacturing environment, data encountered can be categorized into four basic types:
There are four basic steps of data management: storing, retrieving, modifying, and reporting. The data of interest may be in a distributed system at many locations. On the other hand there will be an enormous amount of data pertaining to further complicacy in performing operational tasks such as backup, transaction trace ability, fault tolerance, and security. Comparing it with the current environment in a typical manufacturing firm, where so many difficulties are encountered in managing data in one database so that inventory and bill-of-material records are accurate enough to support MRP. Extensive research is being carried out in the area of data base management system that will support a CIM environment. Most data base management systems arrange data in one of three ways: hierarchical, network, or relational. In a hierarchical structure, data records are related in a tree like manner maintaining a hierarchy as shown in Figure 12.8. A parent record may have several children, but a child record can have only one parent record. In network structure, data record follows many-to-many record. These types of databases are suited for environments requiring high transaction rates and limited access paths. It has been shown in Figure 12.9. In relational database, data is stored as a collection of tables composed of rows and columns. This type of database is appropriate when many unanticipated queries might be made. Usually transaction rate is slower than that of hierarchical or network data base structure. It has been illustrated in Figure 12.10. There are a few database, management systems that provide all three structures, because none of the above can be applied in all circumstances effectively when used in isolation. Research works are in a process to develop an object oriented structure in which data and related attributes are organized as a group with standardized inputs and outputs to make the structure more robust. The application would be under control of the data base management system providing an unchanging user interface. However progress is being made out toward developing a data base management system facilitating the development of a CIM environment and to meet the following desired features of a CIM data base management system:

- Data integration across heterogeneous computer systems
- Transaction processing
- Real-time interactions
- Distributed processing and data
- Multiple views of data
- Levels of security, data integrity
- Multi-user networks across dispersed work environments
- Geometry management
- Versioning
- Backup and recovery
- Good user interface and knowledge based support
- Materials management integration
- Quality assurance integration
- Configuration management
Distributed Data Base Management System

As the capability of networking, microcomputing, and data base management system technologies evolve, distributed data base management are becoming a reality. It is important to distinguish between a networking system providing remote data base access and distributed data base access. It enables user to operate
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on data at one or more remote sites simultaneously and to ensure that work is performed by following procedures that facilitates utilization of this data. In a true distributed database system user is not aware that the data is distributed. The following seven features describe the advantage of distributed data base system proposed by Stonebraker (1989):

(i) **Transparency in Locating Data**: query can be submitted to access distributed data without knowing the location of data.

(ii) **Transparency in Performance Measurement**: query can be submitted from any node running with comparable performance.

(iii) **Crop Transparency**: supporting optional existence of multiple copies of data base objects.

(iv) **Transparency in Transaction**: supports arbitrary transaction that updates the data at a number of sites.

(v) **Transparency in Fragmentation**: allows user to segment a relation into multiple pieces and place them at multiple sites according to certain distribution criteria.

(vi) **Scheme Change Transparency**: enables to make the change only once when adding or deleting a data base object from a distributed database.

(vii) **Local Database Management Transparency**: provides services without regard for the local data base system.

**SAQ 6**

(a) What are the three types of data base structure?

(b) What is data base management system?

(c) Describe the features of distributed data base management system.

(d) Describe the features of CIM data base management system.

**12.8 SUMMARY**

In this unit, we have dealt with the need of a communication system in CIM. Then different network architecture and LAN standards have been discussed. Thereafter different protocols developed by ISO to communicate between different parts of CIM has been elaborated. Different tools for object classification and pattern recognition like sensors, barcodes, transponders, vision system etc. are also described. An overview of control of communication system has been briefly discussed. A brief introduction of database management system in CIM as well as future models of CIM has also been provided. In this unit, we have attempted to cover such basic aspects related to communication and control.

**12.9 KEY WORDS**

**Local Area Network (LAN)**: It is a privately owned network within a single building or campus of up to a few kilometers in size. It is primarily used to connect personal computers and workstations in company offices and factories to share resources and exchange information.
Manufacturing Automation Protocol (MAP) : MAP is a set of protocol standards designed for use in a factory local area network, such as the hierarchical structure.

Protocol : Protocol is an agreed upon format for transmitting data between two devices. The protocol can be implemented either in hardware or in software. Some of the popular protocols are TCP/IP, HTTP, FTP, SMTP, POP, KENING, XMOSEM, MERMIT, etc.