Practical Training Report on
COMMUNICATION & SIGNALING AT RAILWAYS
Training taken from
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Site of Training
Northeast Frontier Railway
Divisional Office - Alipurduar
Jalpaiguri -735101

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PREFACE

Engineering students gain theoretical knowledge only through books. Only theoretical knowledge is not sufficient for absolute mastery in any field. Theoretical knowledge in our books is not of much use without knowing its practical implementation. It has been experienced that theoretical knowledge is volatile in nature; however practical knowledge imparts solid foundation in our mind. To accomplish this aspect, Greater Kolkata College of Engg. & Mang(www.gkcem.ac.in) under "West Bengal University of Technology(www.wbut.net)" has included training for students of B.Tech. III Year of 30 days in our curriculum. We have covered in this report the history, latest developments in Railway electronic interface as well as related fields. We have studied the various uses of EC in railways like railway signaling, data logger, PRS, Microwave Comm., Railnet, OFC etc. This report is in fact a summary of, what I have learnt and seen during my training in "Railway Organization." Succeeding chapters give details what I have learnt in Divisional Railway Manager (DRM) Office, Alipurduar.

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SIGNALING & WORKING OF TRAIN

All over the world Railway transportation is increasingly used, trains carry more loads resulting in higher traffic capacity since trains move on specific tracks called rails, so there is a need to provide control on the movement of trains in the form of Railways signals which indicate to the drivers to stop or move and also the speed at which they can pass a signal. Since the load carried by the trains and the speed which the trains can attain are high, they need more braking distance before coming to the stop from full speed. To safety guide the driver accidents will take place due to collisions.

There are basically two purposes receive and dispatch trains at a station. To control the movements of trains from one station to another after ensuring that the track on which this train will move to reach the next station is free from movement of another train either in the same or opposite direction.

The fixed signals in the form of colour light signals (CLS) are the actual authority to a driver to get in to the portion of the track beyond the signal. To take the train to any specific track, points are provided. The signal has to be connected to the points in an arrangement called interlocking that only ensures that a point is correctly set for the particular route or a track and the signal conveys this information to the driver. The classification of CLS is given as- Trains run on dedicated line. A line consists of two rails running parallel to each other. This is also called 'track.'

Indian railways uses 4 gauges -

- **Broad Gauge** is 1,676mm of 5'6” wide & operational in most parts of the country with 96,851 km of track length
- **Standard Gauge** is smaller than the above with 1,435mm width.
- **Metre Guage** is obviously, 1,000mm wide common in regions with less traffic, such as hilly areas.
- **Narrow Guage** is 610 mm wide, Track sections are rated for speeds 75-160km/hr
ISOLATION refers to methods of protecting one line from the adjacent lines. A train is stopped on one of the lines while another train is moving through on the adjacent line. Commonly now, derailing switches, used that point to sand humps, sidings etc. can be interlocked automatically to isolate the line when signals are taken off for the adjacent line. Sometimes these switches have sensors that automatically bring signals on all adjacent lines, preventing danger. The clearing point is the point of a stop signal up to which the track must be kept clear of obstructions in order for a train to be accepted from the rear of the signal. The distance from the stop signal to the clearing point is the overlap.

INTERLOCKING It is used to prevent unsafe (conflicting) signals. As the points are not set for more than one train that trains may proceed on the same section of track & hence suffering a collision, so various schemes have been developed to set the points and signals controlled by signal box.

- Mechanically operated interlocking schemes that coordinate the positions of the levers controlling the points with the signals governing that section of track and connected branches, loops, or sidings.
- Manually operated interlocking system is common in many hilly areas, although busier lines with catch sidings are being provided with automatically operated delayed signal where the points are controlled by a timer and are set to the main line only after the train has halted for the prescribed period of time.
- Electrically operated interlocking is accomplished by electrical circuitry relays and switches in older electrical systems & computerized circuits in the newer electronic systems.
- Panel Interlocking (PI) is used in most medium-sized stations. Route Relay Interlocking (RRI) is the system used in large and busy stations to handle high volumes of train movements. In this, entire route through the station can be selected and all the associated points and signals along the route can be set at once by a switch for receiving, holding, blocking, or dispatching trains.

NON-INTERLOCKING (NI) here the station master is personally responsible for ensuring that this is done and is supposed to have the keys to unlock the points with him or under his control. Trains are restricted to 15km/h over station limits. Non-interlocked stations are found only on sections with very light traffic.

- Padlocked points: Here a padlock is used to lock the points in position. To operate the points, the station master has to hand over the key for the padlock. The key is usually handed over with a badge or token indicating the route to be set. The procedure takes time and depends on a human for safety.
- Key Locking: Here each set of points has a pair of keys. When the route is set one way, one of the keys is freed and the other must remain inserted at the points; when the points are set for the other route, the first key must be inserted and the other key is freed. The station master keeps free keys in a glass-fronted box so that he can tell at a glance which routes have been set.
- modified non-interlocked (MNI) stations: are those where setting and locking the points releases a key which has to be used to pull off a signal; however, the block instruments are operated independently. So there is some minimal amount of a safety lock between the points and the signals.

Track circuits [used to detect a train by closing an electrical circuit between two rails]
- **double-rail DC track circuits** are generally found only in non-electrified sections.

The track circuit consists of a portion of track which is insulated from rest of the tracks means of insulated rail joints, here bonding wires are provided to maintain good conductivity between adjacent rails. The rails on one side are insulated from those on the other by the use of wooden or non-metallic sleepers. The **track relay** is connected across the two rails at one end, and a DC power source (**track battery**) is connected with the rails at the other end with a **regulating resistance**. When there is no train in the section, the circuit is completed through the track relay which is then energized. When train enters the section, it shunts the current through the track relay, then de-energized, is turned to appropriately indicate at the cabin, then signals control the entry to the section.

- **Single-rail DC Track Circuit**

In 25kV AC electrified areas, it is used. 1 side of the track is used for returning traction current, as adjacent rails being bonded together for conductivity. Rails on the other side are bonded together by track circuit, but insulated at end. The track relay and track battery are connected across the rails within track circuit section. High-voltage fuses are provided to protect the track circuit equipment. The principle of operation is same as double-rail DC track circuit described above.

- **Coded Track Circuit**

Here instead of a steady DC signal, a pulse-coded current is used for the track circuit. The **pulse train** is generated by a **code transmitter**. The **track relay** is energized and de-energized by the pulse train, and controls the current in a **decoding transformer** by switching its taps. A further advantage is that different codes can be used at different times to control the signals.
AC track circuits use an AC signal instead of a DC, advantage is that they are immune to interference from stray currents. AC track circuits may be used on unelectrified or electrified tracks. Impedance bonds are provided for rails at the ends of the track circuit. Impedance bonds provide a path of low impedance for traction currents to flow in both rails, and provide high impedance and therefore block the AC signalling current. A band-pass filter and rectifier are used to extract a DC signal from AC track circuit current, for operation of track relay. The general principle of operation of AC signal is same as DC track circuits.

[Impedance bonds: if the traction currents are distributed across the two rails, there is no resultant flux in the iron core. When the core is not magnetized to saturation and the track circuit current does not face a high-impedance path, an air gap is introduced in the magnetic circuit to prevent saturation, and the impedance bond presents high impedance to track circuit current up to 20% traction current imbalance. In AC track circuit when traction currents are unbalanced, the half coil that carries more current induces an e.m.f. in the opposite half coil that tends to equalize the current. So air gaps are not generally necessary for AC traction. The impedance of the bond to the signalling current can be further increased by adding a secondary coil and capacitor across it, known as a resonated impedance bond. The secondary coil steps up the voltage and allows the use of a smaller capacitor. On one side of the track circuit, other part of the auto-transformer is connected to supply (100V) thereby being stepped down for the track circuit current & the auto-transformer winding on the other side of the track circuit is connected to the track relay so the track circuit current is stepped up to operate the relay. Thus, the current flowing in bonds is usefully employed.]

Audio Frequency Track Circuit (AFTC): Most zones now have many sections that use AFTC that uses 1.5-2.6 KHz. AFTC is more reliable, especially where both DC and AC traction are in use, and allows the track circuit length to be increased a lot. With the low-freq AC track circuits, a band-pass filter & a rectifier are used to extract the signal. However, in many cases an amplifier is needed to strengthen the signal.

High Frequency Track Circuit (HFTC) uses higher freq (40kHz), for the track circuit current. Impedance bonds are not used here. Instead of the track circuit, rail-to-rail shorts are provided. An adapting transformer is used which has one winding across rails with a capacitor in series, transmitter is connected across the winding. Similarly, a receiver is connected across the rails at the other end using another adapting transformer. The transmitter & receiver connections are in a little distance (5m). The receiver usually includes a tuned filter, rectifier, and amplifier for the signal freq. The capacitors are adjusted to tune the enclosed section of the track circuit freq. When no train is on the track, the signal from transmitter is received and detected at receiver, then track relay energized. When a train approaches the track circuit, it shunts the track circuit and depending on the positions of the wheels, either de-tunes the circuit or shorts the transmitter or receiver (or both). Then the track relay is de-energized.
[NOTE: The transmitter may generate pulse trains of specified duration and patterns with the high frequency signal. These are detected and converted to square waves which activate a peak detector. In this scheme, different coded pulse trains can be used to control different signalling.] [* rail-to-rail shorts define the limits of the track circuit and therefore the circuit is immune to interference from adjacent track circuit]

**TRAIN WORKING WITH POWER SIGNALLING:**

Power signalling (i.e., signalling with electricity - usually this means colour-light signalling, but may also include electrically operated semaphore signalling) is usually associated with some specific systems of train working.

**AWS / ATS (AUXILIARY WARNING SYSTEM, AUTOMATIC TRAIN STOP):**

AWS provides prior in-cab notification of home signals that are displaying danger or 'on'. ATS provides a halt in case it overshoots an 'on' signal that it should not have. Some Mumbai-area suburban EMU routes of WR and CR have ATS and AWS systems. If a signal at Caution is passed at above 25km/h, a buzzer sounds in the cabin and the motorman has to respond within 15 sec to avoid application of the emergency brakes. The system also halts the EMU rake if a signal at danger is passed. AWS systems usually work by means of electromagnets placed on the track that are activated by the signal aspects and whose magnetic fields are sensed by the AWS sensor mounted on the loco. A variation of AWS is being tried out on the Delhi-Mathura section where instead of using magnetic sensors a radio signal is used to activate the buzzer.
IR is looking into procuring ETCS level 2 equipment to be installed on the trunk lines between the 4 major metropolises, and later on other main lines. ETCS level 2 equipment allows for comm. of target speeds, safe braking distances, etc. from lineside equipment to the on-board computers of the loco. It includes a measure of ATP **(Automatic train protection)** in that it can slow down/stop a train if required when driver exceeds the safe speeds for given signal aspects; but it does not include full ATC **(automatic train control)**.

A system of ATC is being tried out for Calcutta Metro. When deployed (2001) this will allow for automated routine operations, and reduced headway of 8 or even 5 minutes between the trains (currently 10 minutes on the metro). Delhi Metro uses in-cab signalling and ATC / ATO operation of the subway trains.

**Mobile Trunk Radio Communications (MTRC)** is used on some sections(Bhusawal, Nagpur), which allows the Traction Loco Controller to talk by radio to train crew that are carrying a receiver in the locomotive cab.

**A Train Protection and Warning System (TPWS)**, based on ETCS Level 1 has been proposed for the Chennai - Gummidipoondi section. EMUs will be monitored using track balises and lineside transmission devices (**LEU: Lineside Electronic Unit**). Signal aspects will be available in the EMU cab, and EMUs will be automatically braked if its speed is in excess of the safe speed appropriate for the signal aspect.

**Anti-collision Device (ACD)** Konkan Railway has developed a system involving radio receivers and transmitters fitted on locomotives, which prevents the chances of collisions. The transmitter sends out a coded signal that identifies the train and its direction, route etc.

**OTHER METHODS OF COMMUNICATION WITH TRAIN CREW USED ON IR**

- **Handheld radios (walkie talkie sets)** are widely used now (since 1990s) by train crew, yard crew, etc.). Some stations have transmitters allowing them to broadcast to all walkie talkies in the vicinity. Often, because of their higher power they are able to transmit to walkie talkie sets carried by crew that are farther away than the distance the walkie talkies can normally operate within, so that they can not receive any messages in the reverse direction in such cases.

- The Rajdhani Expresses still use a primitive though reliable form of communication. A pair of wires are connected to a **telephone socket** on the end of the first Rajdhani coach, usually a generator van. This telephone line then goes through the entire rake to the last coach where the guard has a telephone instrument. The driver also has a portable instrument which he plugs into this wire and communication between the guard and driver becomes possible even if the walkie talkies cannot function for some reason.
SYSTEMS IN IR USE FOR CONTROLLING AND REPORTING OF SIGNALS AND RELATED EQUIPMENT

- Panel Interlocking or Route Relay Interlocking are common in most busy stations. Usually, with these the aspects of all signals and positions of trains in various track sections is shown on a control panel. The control circuits usually use underground cables along the track, and sometimes overhead cables.

![Diagram of signal button circuit](image1.png)

ROUTE RELAY INTERLOCKING BUTTON CIRCUITS

- Many areas have data logging equipment for each piece of signal equipment, which records information on the functioning of the signal and sends it to a computer at a central point (usually the division headquarters) where reports can be generated and alarms raised for various kinds of malfunctions (power failure, signal passed at danger, train entering without line clear, signal lamp failure, loose packing of pts etc).

IMPROVEMENTS AND NEW SYSTEMS

Double-wire signalling, devised by E W Baker came into use for operation. This allowed the use of steel wires instead of rodding arrangements. The South Indian Railway and the Assam Bengal Railway were the first to adopt this.

![Diagram of double-wire interlocking with dynamometer](image2.png)

DOUBLE WIRE INTERLOCKING WITH DYNAMOMETER
DATA LOGGER/TRAIN MONITORING SYSTEM

It monitors the movements of trains within the control section from remote control room and graphically simulates online Status of the multiple stations in LCD Monitors.

Technically, a data logger is any device that can be used to store data, includes many devices such as plug-in boards or serial communication systems. Data logger device can read various types of electrical signals and store the data in internal memory for later download to a computer.

The advantage of data loggers is that they can operate independently of a computer. Data loggers are available in various shapes and sizes, powerful programmable devices capable of handling hundreds of inputs. Data logging is now a standard technique within railway signaling engineering for both safety and performance management purposes. Data logging facilitates the past analysis of any event. Data loggers facilitates the continuous monitoring of track, trains, etc. the features are-

- Online Graphical Display of Status of all the Board Station.
- Online Status of all auto sections for effective planning and monitoring of train movements.
- Online status of various assets like points, signals, crank handles, Gates, Axle Counters, Route Relays and Knobs.
- Route Set Indication.
- Details of Train like Train No. / Name passing through a station.
- Details of train(s) in auto section.

RELIABILITY: Contained within the unit is a fully functional Uninterruptible Power Supply giving six hours of battery backup in the case of mains failure. Low power consumption means that no cooling fan is required, which means there are no dust filters to clean or moving mechanical parts to fail. If maintenance is required, the entire unit can be removed simply by disconnecting the input leads and a mains plug.

SAFETY: The Delphi, has been designed specifically to safe railway signaling applications. All digital and analog input channels are opto isolated to minimum 1kV.

DATALOGGER BASED COMPUTERISED TRAINCHARTING (TC)

Data loggers are networked as per control sections. Since the information of the vital relays is available at Control Office, it is possible to track a train and to chart the train movement automatically. The system is not only track the train but also predict the train movement for the next few hours, based on the train information & charting.
All the Data loggers are connected through existing RE telecom cable in series to FEP. The FEP of the Data logger Network is connected to the servers through a computer containing NMDL software with Train charting logics. (See Fig) The client software is provided for viewing the chart / data.

- **ACTIVE CLIENT** is maintained by ATNL who has the control over the train movements and is connected to the server through LAN. At any time, active Client can control the train movement charting. Active Client can feed the Train information as shown in.

- **PASSIVE CLIENT** is used to view the chart anywhere from the network, the chart available at this client is unchanged and cannot be modified. Any number of passive clients can view the train chart by connecting to the server.

**Features of TC**
- Auto tracking of train on real time, Online Plotting of chart.
- Charting of train from starting to destination point.
- Alarm generation & tracking of any new train entered in the section automatically.
- Reporting of deviation from scheduled timings.
- Transparent Control system. Anyone can control chart in control office on LAN.

**ADVANTAGE TC**
- Controller can devote more time on the planning.
- Plotting is on Real time. No human involvement to plot the train so more accurate. Online loop occupancy position.

**LIMITATIONS OF TC**
- Network comm. media should work perfectly to maintain on-line status.
- All the stations of the control section should be equipped with Data logger.
- Train controllers should have basic computer knowledge.
- Continuous track circuiting required.
- **COMPUTERIZED PASSENGER RESERVATION SYSTEM (PRS)**

  The IR carries about 7 lakh passengers in Reservation reserved accommodation every day. PRS facilitates booking and Cancelling of tickets from any of the 4000 Terminals all over the country. These tickets can be booked or cancelled for journeys commencing in any party of India and ending in any other part, with distances up to several thousands kilometre. There are mainly 5 servers in INDIA - **New Delhi**, **Kolkata**, **Chennai**, **Mumbai**, & **Sikandrabad**. The equipment used in PRS are --

- **MODEM**

  are used for communication various computer or between Computer & terminals over ordinary or dedicated telephone lines. We can use modems to log on to micro, mini, main frame computer for line processing. We can use them to connect two remote computers for data.

  The word modem is derived from the words modulate & demodulator. Computer communicate in digital languages while telephone lines communicate in analog language. So an inter mediator required which can communicate both these language. The rate of modem is called bound rate (bits/sec). The speed of the modem transmitting at 600 band is 2400 bps.

  Modem transmits information by modulating the characteristics of the wave that are carried by telephone lines. The modems can transmit data in two formats: Asynchronous & Synchronous. The analog modem switch at each location is connected to the main as well as the stand by links.

- **MULTIPLEXING EQUIPMENT:**

  There are two type multiplexing equipments for each channel. The multiplexer used may be of 8-ports or 16-port. The data is get multiplexed at the rate of the 96KBps. The multiplexing generally of analog type.

- **END TERMINAL:**

  The end terminals of system is the station where the tickets to be Printed out. The terminal consists of a computer system with a dot matrix printer. The number of the total end terminal at the station can be increased or decreased according to the multiplexing used.
The objective of microwave communication systems is to transmit information from one place to another without interruption, and clear reproduction at the receiver.

Above 100 MHz the waves travel in straight lines and can therefore be narrowly focused. Concentrating all the energy into a small beam using a parabolic antenna (like the satellite TV dish) gives a much higher signal to noise ratio.

MICROWAVE LINK can be one hop, consisting of one pair of antennas spaced as little as one or two kilometers apart, or can be multiple hops, spanning several thousand kilometers.

- A single hop is typically 30 to 60 km in relatively flat regions for frequencies in the 2 to 8 GHz bands. When antennas are placed between mountain peaks, a very long hop length can be achieved. Hop distances in excess is 200 km.

- The "line-of-sight" nature of microwaves has some very attractive advantages over cable systems. It only describes microwave paths.

Atmospheric conditions and certain effects modify the propagation of microwaves so it may not be always possible to place antennas at given points and achieve a satisfactory communication performance. In order to overcome the problems of line-of-sight and power amplification of weak signals, microwave systems use repeaters at intervals of about 25 to 30 km in between the transmitting receiving stations. The first repeater is placed in line-of-sight of the transmitting station and the last repeater is placed in receiving station. The data signals are received, amplified & retransmitted by each of these stations.
**RAILNET (RN)**

The Indian Railways is Asia's largest and the world's second largest rail network. For benefit of IT explosion, Indian Railways have established a 'Corporate Wide Information System' (CWIS) called RAILNET. It provides smooth flow of information on demand for administrative purposes, which would enable taking quicker and better decisions. Realising the important role that information plays in customer services and in railways operations.

**IVRS (INTERACTIVE VOICE RESPONSE SYSTEM)**

The system in which, the info available in the computer is retrieved by the user in the form of voice with the help of the interaction between telephone and computer is known as IVRS.

Each section control office is having a computer called DATA ENTRY COMPUTER along with dial up/lease line modem which is used for linking the computer of other control offices directly. Each control office computer is identified as check / data entry point. Information regarding the running of the train can be registered or checked at every 15 minutes duration.

At place where the information is to be retrieve through Telephone, another computer is linked with data entry computer called IVRS COMPUTER, which is connected to data entry computer by ETHERNET CARD. These computers read the information from data entry computer and then convert it to voice for user purpose. It uses 3 softwares-

**FRIENDLY USER SOFTWARE**, it is used to record the train schedule timing information in data files. This software is having facilities-

- The system is secured by 3 stages of password facility.
- It is having the facility for data entry or removal of running/schedule time.
- Entry for expected arrival/ departure of train
- Changes in the database for timetable; fare table etc.
- It restricts the entry of train after a specific period i.e. the file is deleted for a train after 2 hours of its arrival; and deletes the files which are 48 hours old and reorganize the files.
- This software is having a facility to generate -
  (a) Status of running train as per—According to train, According to control office
  (b) Information of train, when the train is late more than specific hours, train graph

**COMMUNICATION SOFTWARE**: works on the principle of packet switching in which each train file is developed in the form of packet along with destination address. When a pop file is generated after every 15 minutes in data entry computer, then file is transferred to its queue directory. When HUB computer is connected to data entry computer, HUB searches the files from queue directory and then down load in its receive directory and similarly the queue directory files available in HUB will be received and stored by data entry computer. The comm. software is also having the facility for CRC check (cyclic redundancy check) and receive
check. So in case of line failure or modem faulty, when the file could not be exchanged, then HUB try to establish the link and if is not able, then it will create alarm; and show link break , The facilities of comm. software:

- Auto dialing facility for origination of transmission of information or data.
- Having facility of auto pickup of file from remote queue directory.
- Facility of auto transfer of own file to remote/required place maintaining periodicity.
- It has facility to support WAN and is capable of interfacing with any type of communication system like Internet, leased line.
- It is provided with the list of transmitted files and remaining files.

OLTRIS SOFTWARE- “ON LINE TRAIN RUNNING INFORMATION
used to changed the route of the train; accident of train; abnormal delay/late of the train and so on. So the software is developed to support all the abnormal activity. This software is having the following facilities:

- It is having the facility to interact with both pulse and tone users.
- It is having a facility of FAX on demand, for that separate terminal is provided.
- It is supporting and select more than one language.
- According to traffic, ports can be increased or decreased.
- It is having the facility of mailbox.
- It gives a report of no. of calls in 24 hours and the calls in a specific period.

CONCERT (COUNTRY-WIDE NETWORK OF COMPUTERISED ENHANCED RESERVATION & TICKETING): IR fully automated PRS software, is based on client server architecture interconnecting the regional computing system into a National PRS grid. It allows passenger can book for a journey in any train from anywhere to anywhere, cancellation/ refunds.

E-TICKETING CRIS (CENTRE FOR RAILWAY INFORMATION SYSTEM): has developed the Internet ticketing solution launched by IRCTC. The effort involved interfacing the IRCTC front end with backend PRS Alphaservers, writing procedures for search and queries at the backend, ticket printing on existing clients & accounting software.

UTS (UNRESERVED TICKET SYSTEM): UTS is the complete solution for computerised unreserved ticketing from dedicated counter terminals and replaces manual Printed Card Tickets/Excess Fare Tickets/Blank Paper Tickets.

IVRS (INTERACTIVE VOICE RESPONSE SYSTEM): IVRS is a telephonic enquiry system which information such as Passenger Name Record (PNR) enquiry, Train Arrival/Departure enquiry through NTES, and Berth availability position in any train, in multiple languages.

NTES (NATIONAL TRAIN ENQUIRY SYSTEM): provides current status information about any passenger train in the entire Indian Railways Entries are made regarding running of train every half an hour at various locations including divisional headquarter all over the Indian Railways. NTES is used by web enabled services and mobile services for providing train info to the public.
RAILNET MIS

For running any business organisation, the efficiency of the MIS is very important. The divisional offices, Zonal training institutes will be connected to rail net in phase 3 and finally to station, yards, shads etc. RN comprises of

1. **INTRA-NET** - It is a digitized internal network allowing the railway officers & staff to communicate.
2. **INTER-NET** - It allows user to get into a global communication method and global pool of knowledge, through **WWW** (World Wide Web) in a secured manner.

**TOOLS:**

- E-Mail, EDI (Electronic Data Interchange)
- WWW
- FTP (File Transfer Protocol), TCP (Transmission Control Protocol)

**OBJECTIVES**

- Creation of Web pages, E-mail.
- Voice-over IP, Video-conferencing
- Web-based application software development
- Web surfing (Browser usage for internet and intranet).

**HARDWARE COMPONENTS:**

- ‘Compaq’ Servers, ‘CISCO’ Routers, Switches & Hubs
- Structured cabling using UTP-Cat 5 cabling (10 MBPS) (Max distance 100m between )

RAILNET NETWORK COMPONENTS
A. SERVER: A shared machine together with the software programs which handles requests and distributes the network resources such as data files and printer time both the machine and its software are jointly referred as the server. Server has following characteristics:

- motherboard of the server is entirely different from a normal PC
- It can be used with two processors of 500MHz.
- It contains 3 hard disks of 9GB, connected to motherboard through RAD controller card
- A server should be able to implement security for its data.
- It contains Microsoft Back Office Server 4.01 software which comprises:
  a) Microsoft NT.
  b) Microsoft Back Office.
  c) Site Management Server.
  d) Proxy Software.
  e) Service Network Administrator.
  f) Exchange Server.

B. ROUTER: A router translates information from one network to another selecting the best path to route a message, based on the destination address and origin. The router can direct traffic to prevent head-on collisions. Routers can "listen" to the entire network to determine which sections are busiest, they can avoid those sections until they clear up. Routers can:

- Route messages between 2 protocols across fiber optics, coaxial, twisted pair cabling
- Route messages between linear bus, star, and star-wired ring topologies.

C. SWITCH: The switch is used to interconnect the Nodes. It is more complex and versatile. They are active device with following points

- 10Mbps, 100 Mbps, single-speed, or dual speed operation.
- Congestion control, means switch should have enough buffers to take care of traffic.
- Segmentation of local network
- Speed up the local network. They are of 8, 16 or 48 ports active terminal.

D. FIREWALL: It is security purpose software, used to secure the server contents, so the outsider can't temper the info, user can read the information but cannot write anything.

E. HUB: It is active junction box, used to connect the nodes and all the servers using any type of cable (UTP, Coaxial etc). It contains a division of network bandwidth. The important parameters to be considered while selecting are:

- Support for dual-speed operations, auto switching
- Number and types of ports, UTP and BNC.

It can have a capacity of 8, 16 or 24 nodes and the maximum distance between Hub and nodes is 100 Mt. If distance is more, then additional HUB must be used (not more than 3).
OPTICAL FIBER COMMUNICATION

Today's general demands to railway administrations all over the world are - improved traffic regularity, more frequent departures & shorter travelling times. To meet this demand, it is has to expand the existing transmission capacity for tele-communication and implement more flexible signal interlocking systems. The telecommunication network has to operate with a number of new services, such as automatic train number, electronic reporting and passenger information, freight control etc.

COMMUNICATION MEDIA:- The communication links making up the data network may be over a combination of any of the following media-

- OFC
- Digital & analog MW, IP Radio links
- VSAT, Twisted pair copper
- Feasible wireless LAN (WiFi)

The earlier networks were non-IP based & worked at speeds of 9.6 Kbps. Presently networks are mostly IP based, operate at speeds of 2Mbps at the core & distribution levels and 64 kbps at the access level. In a centralized system as in FOIS,

- **CORE LEVEL** comprises the communication links between CRIS (Centre for Railway Information System).
- **DISTRIBUTION LEVEL** comprises the communication links between zonal Hqrs. And divisions and connect the division to the activity centres. In a distributed system as in PRS, the computers at the 5 metro cities are connected in a mesh topology and form the core network. The network connecting the 5 locations to other zonal headquarters and divisional headquarters forms the distribution layer and the connections from the zonal/divisional headquarters to the other locations forms the access network.

NETWORK SECURITY: Data sent by the sender should be received only by the intended receiver. This is achieved through encryption at various levels. The various data encryption standards are IP sec, DES, 3DES, AES, private/public key etc.
OPTICAL FIBER TELECOMMUNICATION FOR RAILWAY UTILITY

A modern telecom network for railway utility must be able to handle advanced remote control centres, digital telephone exchanges, train radio systems and the extensive development of central and local data systems. Therefore, it is recommended to apply digital PCM transmission equipment, using optical fibers as transmission media. This kind of telecommunication networks are the lowest ablishing costs compared to its enormous capacity. For example, an 8 or 12 fiber cable is able to handle all today known railway transmission requirements and even more. The transmission network is immune to electromagnetic disturbances in connection with electric railway traffic.

In optical fiber telecom systems, primarily monomode fibers are used today, providing an extremely high bandwidth (300GHz km) and a very low attenuation (0.2 dB/km). Fibers are also used for illumination, and are wrapped in bundles so they can be used to carry images, thus allowing viewing in tight spaces, including sensors and fiber lasers applications.

An optical fiber is a thin, flexible, transparent fiber that acts as a waveguide or "light pipe", to transmit light between the two ends of the fiber. Optical fibers are widely used in fiber-optic communications which permits transmission over longer distances and at higher (data rates) than other forms of communication. Fibers are used instead of metal wires because signals travel along them with less loss & are also immune to electromagnetic interference.

OFC COMM. NETWORK AT IR

IR Vision is to tap revenue generation potential in the telecom and IT sector, using the 64,000-km long 'right of way' for laying optic fibers, signalling towers & other infrastructure assets that Indian Railways owns. OFCs are laid down along the track. This will be done in collaboration between the RailTel Corporation & private sector companies in a transparent framework. The advantages of using OFCs over conventional copper cables include:

- free from EMI and RFI making it especially useful in electrified areas.
- supports low bit-error rate digital communication.
- very high traffic carrying capacity
- negligible cross-talk between channels, high speech quality.

JOINTING AND TERMINATION OF OFC TECHNIQUES

1.MECHANICAL SPLICE: This align the axis of the two fibres to be joined and physically hold them together.
2.FUSION SPLICING: This is done by applying localized heating (by electric arc / flame) at the interface between the butted, pre-aligned fibre end, causing them to soften & fuse together.

Following steps are involved for jointing of the cable:-

- Preparation of cable for jointing
- Stripping/cutting the cable
- Preparation of cable and joint closure for splicing
- Stripping and cleaving of fibres