Signalling& Telecommunication Engineering

Lesson 3

Telecommunication

1.0 Introduction

1.1 A country's Railway system depends very heavily on good and reliable communication. In fact it can be said that without a proper communication system the Railways would be like a human without a nervous system.

1.2 The Indian Railways (IR), is divided, for administrative control and train operation, into a number of Zones, which are further divided into number of divisions. The divisions are the level that deal with the public, like issue of tickets, booking of goods and parcels, day to day train running, and maintenance of assets, like rolling stock, permanent way, signaling etc. They also deal with periodic overhauling of the rolling stock. Day to day income, and expenditures are incurred on the divisions. For effective administrative and technical control, the divisional headquarters needs to be in daily contact with all important points on the division. In turn, the zonal headquarter needs to be in contact with the Divisions, and other important places like workshops and depots, and the Railway Board needs to be in contact with the Zonal Hqtrs. and other important places. There are in addition, a number of manufacturing units for locomotives, coaches, wheels and axles, directly under the Rly, Bd. There are other important organizations like the RDSO, Central Organization for Railway Electrification, and Metro Calcutta that function under the Railway Board. Presently, there are 16 zonal Railways, a number of Production units and special organizations, and 82 divisions. These zones and production units etc. are spread over the country. It need not be emphasized that the telecommunication system required to cater to such a system needs to be large, and very reliable.

1.3 For train running, special communication is required. The Railway network has been divided into a number of sections, train running on which is controlled by a train controller. This section is called a 'control' section. The controller needs to be in constant contact with all the stations on the section. Also, two adjacent controls need to be in contact for co-ordination purposes. The controls need the facility of calling any of the stations to pass on instruction and to monitor actual, train running.

1.4 Broadly, a railway's telecommunications must cover two communication requirements,

The telecommunication system must provide,

(a) An administrative control network, and

(b) A train control network.

1.5 In the early years of Indian Railways, the telecommunication circuits were provided

mainly by the Department of Telecommunications. As the requirements grew with the expansion of the Railway network, it was felt that the Railway must provide its own communication rather than depend on another department. Progressively, the Railways started to provide not only local communication circuits, but also long distance links. Presently, the Railways provide and maintain almost the entire telecommunication system themselves. There are only a few links which are still provided and maintained by the Department of Telecommunication.

2.0 Types of Circuits

The types of telecommunication circuits can generally be classified as those used for,

(a) Message transmission, or

(b) Voice transmission, or

(c) Data circuits

3.0 Transmission of Messasges

Messages are sent for various purposes like train working, maintenance requirements commercial purposes etc. These are sent by means of:

(a) Telegraph Circuits, or

(b) Teleprinters, or

(c) Facsimile

3.1 Tele graph &Teleprinters are almost totally abolished whereas Facsimile, also called fax machines are still in use. Fax machines are electronic machines where a document, which may be a typed or handwritten document, or a drawing or plan is scanned by a machine at one end and is reproduced at the other end on a similar fax machine. This is quite fast and also needs no knowledge of even typing. Also as mentioned, it enable drawings, plans, texts, tables, a monogram or even signatures to be transmitted. This is now the preferred mode of message transmission.

4.0 Voice Transmission

This enables a person to talk to one or more persons and is a very vital requirement in communication system. Voice communication can be:

(a) Point to point, or

(b) Point to multi-point

4.1 Point to point circuits are those which connect one point to the other. This enables quick communication between the two points. This can give very reliable communication and also enables instant communication.

4.2 Point to multi-point communication enables one point to be connected to many points as

per requirement. This requires the need of switching circuits and is done in exchanges.

4.3 Various types of telephone exchanges are used by the Railways. They can be,

* Automatic
* Electronic
* Digital
* Stored Programme Controlled (SPC)
* Pulse Code Modulation (PCM, Time Division Multiplexing (TDM) technology I P exchange.

4.4 The exchanges shall be Transit cum Local Exchanges providing connectivity between:

* Subscriber to Subscriber
* Subscriber to trunk
* Trunk to Subscriber
* Trunk to trunk

5.0 Trunk Circuits

5.1 Long distance communication circuits are called trunk circuits. These are used to put through calls to distant subscribers like connecting zonal subscribers to the divisional subscribers or divisional subscribers to subscribers at an important place on the division. The circuits can be:

(a) Manual-requiring an operator at one or both ends, or

(b) Automatic-where distant subscribers can be directly dialed, called Subscriber Trunk Dialing or STD.

Both types of circuits are used on IR. STD circuits are being used more and more as this puts through call faster, and also since secrecy is maintained.

5.2 The Indian Railways have an extensive network of optic fiber cable for providing trunk circuits. Almost all important places like the zonal and divisional headquarters are linked by IR's OFC network.

6.0 Train Traffic Control Circuits

6.1 The train traffic control circuits, as the name suggests, are used to control movement of trains. These are special circuits used exclusively for this purpose and hence are required to be very reliable.

6.2 For operational purposes, the Railway network is divided into sections of about 150 to 250 km called control sections. Train working on these sections is supervised by a 'controller' who is in constant touch with the station staff. The arrangement is such that

the controller is available on phone all the time. The station staff can contact the controller simply by lifting the control phone and talking. When the controller needs to call the station staff, he has the facility of ringing up a particular station. The ringing can be to a particular station or by a group call to all the stations simultaneously.

6.3 The control circuit is an omnibus circuit. All the stations, as well as the controller are connected in parallel. The controller has a special ringing arrangement for signalling a station.

6.4 One of the advantages of an omnibus link is that all stations on section are on a common link. The most commonly used ringing arrangement uses a system of transmitting a series of dc pulses. Three strings of 17 pulses punctuated by two pauses are used for coding purposes. At the controller's end, pre-coded keys, or push buttons have to be operated by the controller. At the stations special 'selectors' sense the incoming pulses and get actuated. The selectors are so programmed that only the selector that has the required code gets rung, while all others get released. Now a days this system of ringing is almost completely replaced by DTMF system. In this system controller has to press two digits number allotted for a particular way side station on the headquarter equipment. Correspondingly two tones are generated for each digit. These tones are sensed by only programmable way side equipment which is programmed for those particular tones. All that is required is, that the controller has to ring up the concerned stations so that the station staff can attend. Another advantage is that a station can just pick up the control telephone and get instantaneously in touch with the controller. There is no delay due to ringing or the controller being 'engaged'. This is particularly important in emergencies or accidents, when a delay could be crucial. Also, when special messages have to be passed to all the stations, it is possible to ring up all stations simultaneously, by a group ringing arrangement.

6.5 Based on traffic requirements, and catering to requirements of 25 KV ac electrified areas, a section may be provided with one or more control circuits as mentioned below:

(a) Section Control/Train Control- this is provided between the section controller and the stations on the section, and is used for controlling train movements.

(b) Deputy control –This control circuit is provided for supervisory control of train movements. It connects the deputy controller in the control office to all important stations, yards, loco sheds etc.

(c) Loco Power Control – this is provided between the power controller in the control office and the loco sheds, important stations, and yards on the division for controlling movement of locomotives.

(d) Traction Power Control – this circuit is provided on the electrified sections for coordination and efficient utilization as well as maintenance of the traction supply and the overheads system. This circuit connects the traction power controller in the control office to the grid stations, feeding posts, sectioning posts, sub-sectioning

posts, important stations and concerned divisional officers.

(e) Stock Control – this circuit connects the stock controller in the control office to the yard masters and important stations on the division for controlling the movement of rolling stock.

(f) Emergency Control – this is a special circuit provided in electrified territories At selected points along the track, special sockets are provided. Emergency phones are provided to the train crew, track maintenance staff, traction maintenance staff and other staff who may need to work in the section. By inserting the emergency phone plug in the emergency sockets, it is possible for the staff at site to contact the control office. When a train is immobilized or meets with an accident, the emergency control is used to get the required help through the control office. In non-electrified territories, generally overhead wires are used for section control working. Loco pilot and maintenance crew are given portable control phones set, which can be hooked onto the overhead wires to contact the section controller.

7.0 Data-Network

7.1 The interconnection of a large number of data processing devices through suitable communication links enabling data transfer between the data processing devices constitutes a DATA NETWORK. Several data networks are functional over Indian Railways and year by year, rapid expansion of the networks takes place to cover more and more activity centers. The architecture of the networks is also upgraded in a phased manner to keep in tune with the technological developments. Several applications are already operating over the networks and many new applications are contemplated .The various applications are as under:

a. Passenger Reservation System (PRS)

b. National Train Enquiry System (NTES)

c. Unreserved Ticketing System (UTS)

d. Control Office Automation (COA)

e. Crew Management System (CMS)

f. Material Management Information System (MMIS)

g. Freight Operations Information System (FOIS)

h. Coaching operations Information System (COIS)

i. Management Information System (MIS) which is made up of a large No. of applications for various departments like AFRES (accounting), PRIME (Personnel) etc. The data networks can also be used for other applications like video conferencing, data conferencing, VOIP, IVRS, disaster management, office automation etc.

7.2 Private and Public Networks:

a. Railway applications primarily run over Railways' Private Network, i.e. only Railway applications are transported by the network. In contrast, in the Public Networks, like INTERNET, various applications used by the public are carried by

b.Railways Private Network is built up by utilizing bandwidth from Railways' own Railtel Corporation of India (RCIL) or leasing bandwidth from BSNL or other service providers.

8.0 Types of Communication Channels

8.1 For meeting Indian Railway's communication needs, different types of communication channels have been used. These are based on requirements, as well as availability. IR has taken advantage of the latest developments in transmission technology to provide high capacity circuits with capability of data transmission.

8.2 The various types of communication channels/lines used on the Indian Railways are:

(a) Overhead wires.

(b) Twisted pair cables,

(c) Quad cables,

(d) VHF/UHF

(e) Satellite Links.

(f) Microwave links

(g) Optical Fiber systems.

8.3 Overhead Wires

8.3.1 On the non-electrified routes, these have traditionally been used for all control, block and telegraph circuits. Local subscribers have also been connected to telephone exchanges using overhead wires. These are comparatively cheap and do not require sophisticated maintenance facilities. Faults when they occur, can be easily localized and rectified. However, such systems are prone to frequent interference, thefts, and easily affected by storms, tree branches falling etc. Also overhead wires can be easily tapped.

8.3.2 They are capable of normally carrying only one channel. By using carrier systems a limited number of additional channels can be derived. Due to line losses, such overhead wire systems can be used only over short to medium distances only. This is because repeaters are not generally provided for technical reasons.

8.4 Twisted Pair Cables

Twisted pair cables are generally used only for local leads in telephone exchanges, or for

linking low speed systems over short distances. These consist of multi-pair cables with a pair being formed by twisting together two conductors.

8.5 Quad Cables

8.5.1 Quad Cables consist of multi conductor cables so constructed, that four conductors are taken together and form two balanced pairs into a quad. A cable may have a number of quads.

8.5.2 Quad cables have been used for some of important control circuits, block and other circuits in the. The quad cables used are shielded to provide immunity from ac induced voltages, and the quad construction allows provision of repeaters. Thus long distance working is possible.

9.0 VHF/UHF Links

9.1 Very High Frequency (VHF) Communication

The frequency band of VHF Communication is 30 to 300 MHz Frequency band utilized byIndian Railways are:

(a) 85.5 to 86.5 MHz

(b) 146.2 to 167.95 MHz

Possible uses of VHF Communication on IR are:-

- Communication during Maintenance and Constructional Blocks
- Yard communication - Communication in the train in between Guard &Loco pilot
- Mobile Communication in between moving train/vehicle with fixed location (Station) or another moving train/ vehicle.
- Emergency Communication: - ART equipped with hand held and base station VHF sets.
- Duplex VHF Sets are utilized for
- Extension of exchange number to distant place.
- Control working. (Train Traffic Control)/Patching.
- Universal Emergency Communication for communication between Loco pilot, guard, Station master & Cabin.

10.0 Microwave Links

10.1 Generally, frequencies higher than 2000 MHz are called microwave frequencies. These travel in straight lines and due to their small wavelength, employ small antennas. Due to the high frequencies used, and the consequent atmospheric attenuation, IR uses repeaters after approximately every 50 kms. Towers of up to 100 meter are provided at the repeater

stations, with parabolic dishes used as antennas.

10.2 For a long time microwave links had been used to form the backbone of IR's communication system. All important routes were provided with microwave links. The MW links were used for administrative trunks, for radio patching of control circuits, for linking telephone exchanges, for data transmission where digital links are provided, and for control working on the 18 GHz system. Now a days Microwave links almost replaced by the OFC links.

11.0 Opitical Fiber Systems

11.1 Optical fibers are now extensively used in modern communication links. These employ special glass fibers to transmit light. The light passes through solid tubes of fiber glass with very low attenuation. The light is modulated for transmitting data. The fibers are very thin and are bunched together to form multi fiber cables. Optical fiber transmission permits very large bandwidths.

11.2 Optical fiber systems score over copper cables in many ways. Since such cables have no copper, there is no theft problems as in copper cables. Also, absence of any metallic conductors, results in absence of ac induced voltages. This makes them very attractive for use in 25 KV ac electrified areas. Optical fiber cables have very high bandwidths and can, therefore cover all communication requirements of the Railways. They can also be used for data transmission

11.3 The Indian Railways have already provided optical fiber systems on almost all routes. These systems will cater to all administrative as well as operational requirements on these section

12.0 Satellite Communication (Very Small Aperture Terminal (VSAT) Network)

12.1 Introduction VSAT provides Point to Point or Point to Multi Point data connectivity using Geostationary Satellite as repeater location. As satellite is being used as repeating stations, the data originating and terminating point can be anywhere on the earth. VSAT networks are typically used in Indian Railway to provide data connectivity between various goods terminals and CRIS as well as for video conferencing applications. It shall also be used for Accident Site Communication for voice, data and video transmission

12.2 Satellites can be placed in geostationary orbit of the earth. This means that they circle the earth at a speed such that they appear to be stationary with respect to a point on earth.

Theoretically, three satellites, strategically placed, can cover the entire globe and can enable communication from any point on earth to any other point.

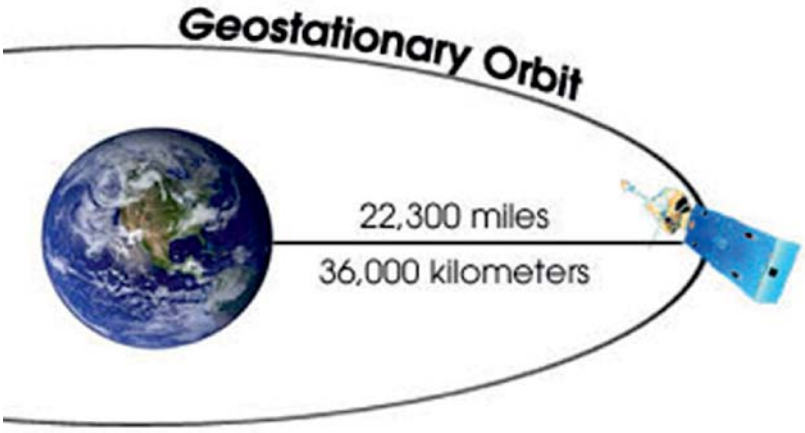

Fig 1 Satelite Communication

12.3 The satellites carry transponders that receive signals from the earth, and beam them back to earth either directly or via another satellite. On the earth, these signals are received and are fed to the terrestrial network to link the required subscriber. The frequencies used are in the microwave band, and follow line of sight transmission.

12.4 While satellite circuit are expensive, they can be made available quickly, since there is no need to provide any infrastructure like masts, or radio-relay systems. Thus when there is need for a few channels, particularly to a remote location, satellite channels can be cost effective.

12.5 Another advantage of satellite communication is that it is easy to provide mobile communication. All that is required is a terminal that can send/receive to the satellite. Today a number of such light-weight portable sets are available, which can establish communication from anywhere via a satellite. The Indian Railways has provided communication from a moving train in the Rajdhani Expresses running between Mumbai and New Delhi, and in the other Rajdhani Expresses. This service is being provided via the INMARSAT satellite. Similar portable phones are also used for Railways' accident relief trains.

13.0 Mobile Train Radio Communication

Mobile Train Radio Communication System are being provided on selected sections of Indian Railways so as to provide communication between Loco pilot to Guard, Loco pilot /Guard to Station Master, Loco pilot /Guard to Control and other staff engaged in train operations. GSM-R based system has been identified as the technologies for all MTRC systems.

Basic featue of the GSM-R

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Point to Point call	Allows user to make a distinct call.
Voice Broad cast call	Allows groups of user to receive common information.
Voice Group call	Allows groups of user to make calls within /among the groups.
Emergency call	Allows user to call controller by short code or button during emergency
Functional addressing	Allows a user or an application to be reached by means of a number, which identifies the relevant function and not the physical terminal.
Location dependent addressing	Provides the routing of mobile originated calls to the correct controller e.g. relative to the geographic area
eMLPP (enhanced Multi-Level Precedence and Preemption)	Allows resource preemption for priority calls

BIBLIOGRAPHY

1. Indian Railways General and Subsidiary Rules
2. Indian Railways Block working Manual.
3. Indian Railways signal engineering Manual.
4. Indian Railways Telecommunication Manual.

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