CHAPTER 12

TELECOMMUNICATION & AUTOMATIC FARE COLLECTION

Chapter – 12

Telecommunication & Automatic Fare Collection

12.1 TELECOMMUNICATION

12.1.1 Introduction

The Telecommunication system acts as the communication backbone for Signalling systems and other systems such as SCADA, AFC etc and provides Telecommunication services to meet operational and administrative requirements of metro network.

12.1.2 Overview

The Telecommunication facilities proposed are helpful in meeting the requirements for

1. Supplementing the Signalling system for efficient train operation.
2. Exchange of managerial information
3. Crisis management during emergencies
4. Passenger information system

The proposed Telecom system will cater to the following requirements:

- Train Traffic Control
- Assistance to Train Traffic Control
- Maintenance Control
- Emergency Control
- Station to station dedicated communication
- Telephone Exchange
- Integrated Passenger Announcement System and Passenger Information and Display System within the station and from Central Control to each station.
- Centralised Clock System
- Train Destination Indicator
- Instant on line Radio Communication between Central Control and Moving Cars and maintenance personnel.
- Data Channels for Signalling, SCADA, Automatic Fare Collection etc.

- E&M SCADA is not envisaged as part of Telecomm System as such, hence catered to separately in DPR.

12.1.3 Telecommunication System And Transmission Media

i) Fibre Optic System (FOTS) - Main Telecommunication Bearer

The main bearer of the bulk of the Telecommunication network is proposed with optical fibre cable system. Considering the channel requirement and keeping in view the future expansion requirements a minimum 48 Fibre optical fiber cable is proposed to be laid in ring configuration with path diversity.

SDH (minimum STM-16) based system shall be adopted with SDH nodes at every station, depot and OCC. The SDH equipment shall be equipped with Ethernet Card to provide channels to other interfacing Contractors of SCADA, PA/PIDS etc. Further small routers and switches shall be provided for LAN network at stations/depot. Alternatively a totally IP Based High Capacity, highly reliable and fault tolerant, Ethernet Network (MAN/LAN) can be provided in lieu of SDH backbone.

ii) Telephone Exchange

For an optimized cost effective solution Small exchanges of 30 port each shall be planned at each station and a 60 Port Exchange at the Terminal Stations shall be provided. The exchanges at Central Control and Depots shall be of larger sizes as per the actual number of users. The Exchanges will serve the subscribers at all the stations and Central Control. The exchanges will be interconnected at the channel level on optical backbone. The exchanges shall be software partitioned for EPABX and Direct Line Communication from which the phones shall be extended to the stations.Alternatively only for non-operational (other than Direct Line Communication), a separate IP Based Phone System can be implemented.

iii) Mobile Radio Communication

Mobile Radio communication system having minimum 8 logical channels is proposed for on-line emergency communication between Motorman (Front end and Rear end) of moving train and the Central Control. The system shall be based on Digital Trunk Radio Technology to TETRA International standard. This system now is widely adopted for mobile radio communication in metro / rapid transit services abroad. All the stations and the OCC will be provided with fixed radio sets. Mobile communication facility for maintenance parties and Security Personnel will be provided with handheld sets. These persons will be able to communicate with each other as well as with central control.

The frequency band for operation of the system will be that for TETRA in 400/800 MHz band, depending on frequency availability. The system shall provide mobile radio communication between the motorman of the moving cars from any place and the Central Control .The motorman can also contact any station in the network through the central control, besides intimating the approaching trains

about any emergency like accident, fire, line blocked etc., thus improving safety performance.

To provide adequate coverage, based on the RF site survey to be carried out during detailed Design stage, base stations for the system will be located at sites conveniently selected after detailed survey. Tentatively minimum 6 sites with towers with Base Stations shall be required along the East – West (EW) Corridor at Mahindra & Mahindra, Rachna (Ring RD JNC), Lad Chowk, Jhansi Rani SQRE, Dosar Vaisya Chowk (Mayo Hospital) and Telephone Exchange Stations. For the North – South (NS) Corridor, at least 5 Base Station with Towers shall be required at Mihan City, Mayuresh Station, Rahate Colony, Zero Mile and Kadvi Chowk Stations.

For the Underground Section of North-South corridor, one Base Station shall be required at New Airport feeding through Leaky Coaxial Cables, the adjacent tunnels.

In addition to the TETRA Radio Coverage for the internal use of the Metro, the city is also likely to have Mobile Coverage from Private Operators.

In the elevated sections it is expected that coverage shall be available from the adjoining sites of the Mobile Operators. However, in the underground stations / tunnels, coverage needs to be specially extended by the Mobile Operators. To enable the Mobile Operators to do so, the Metro Authority will have to have an agreement with a group of Mobile Operators according to which Metro shall provide an Air-conditioned room (approx. 20 sq. m) at the underground station to the Mobile Operator Group. The Mobile Operators shall install all their repeater equipment in this room and then extend the coverage inside the tunnel by laying their own LCX cable in each tunnel and through antennas strategically placed in the concourse area. Further, for City Emergency Services like Police, the mobile operators shall also design their LCX network to support the police wireless coverage in the tunnels /station area. The detailed Agreement covering both the Mobile / Emergency Service Radio Coverage shall have to be finalised by the Metro Authority with the respective parties, at the time of implementation.

iv) Passenger Announcement System

The system shall be capable of announcements from the local station as well as from OCC. Announcements from Station level will have over-riding priority in case of emergency announcements. The System shall be linked to Signalling System for automatic train actuated announcements.

v) Passenger Information Display System

These shall be located at convenient locations at all stations to provide bilingual visual indication of the status of the running trains and will typically indicate information such as destination, arrival/departure time, and also special messages in emergencies. The boards shall be provided at all platforms and concourses of all stations. The System shall be integrated with the PA System and available from same MMI.

vi) Centralised Clock System

This will ensure an accurate display of time through a synchronization system of slave clocks driven from a Master Clock at the operation control center. The Master Clock signal shall also be required for synchronization of FOTS, Exchanges, Radio, Signaling, etc. The System will ensure identical display of time at all locations. Clocks are to be provided at platforms, concourse, Station Master's Room, Depots and other service establishments etc.

vii) Closed Circuit Television (CCTV) System

The CCTV system shall provide video surveillance and recording function for the operations to monitor each station. The monitoring shall be possible both locally at each station and remotely from the OCC on a Video Wall.

The CCTV system backbone shall be based on IP technology and shall consist of a mix of Fixed Cameras and Pan/Tilt/Zoom (PTZ) Cameras. Cameras shall be located at areas where monitoring for security, safety and crowd control purpose is necessary.

For monitoring of inside of Train, a wireless CCTV System from Train to nearest station shall be provided. For this a wifi Broad Band network will be provided at each station, so as to automatically upload On-Board CCTV Video from the Train to the OCC at each station. The Broad Band Radio System shall be based on unlicensed wifi Band and shall use the Optical fibre backbone network to transfer video from the station to the OCC. The On- Board Train Cameras shall be provided as part of the Rolling Stock Contract and they shall interface with a On-Board wifi equipment provided by Telecom Contractor to transmit video to station equipment.

viii) Network Monitoring and Management

For efficient and cost effective maintenance of the entire communication network, it is proposed to provide a network management system (NMS), which will help in diagnosing faults immediately from a central location and attending the same with least possible delay, thus increasing the operational efficiency and reduction in manpower requirement for maintenance. The proposed NMS system will be covering Radio communication, Optical Fiber Transmission, Telephone Exchange and summary alarms of PA/PIDS, CCTV and Clock System.

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Technology

The Technologies proposed to be adopted for Telecommunication systems are shown in below:

Table12.1 : Technologies for Telecommunication systems

System	Standards
• Transmission Media	Optical Fibre system as the main bearer for bulk of the Telecommunication network
• Telephone Exchange	EPABX of minimum 30 ports is to be provided at all Stations, an Exchange of 60 Ports to be provided at Terminal Station

System	Standards
• Train Radio System	Digital Train radio (TETRA) communication between motorman of moving cars, stations, maintenance personnel and central control.
• Train Destination Indicator System	LED/LCD based boards with adequate visibility to be provided at convenient location at all stations to provide bilingual visual indication of the status of the running trains, and also special messages in emergencies.
• Centralized clock system	Accurate display of time through a synchronisation system of slave clocks driven from a master clock at the OCC and sub – master clock in station. This shall also be used for synchronisation other systems.
• Passenger Announcement System	Passenger Announcement System covering all platform and concourse areas with local as well as Central Announcement.
• Redundancy (Major System)	Redundancy on Radio's in the Base Stations, Path Redundancy for Optical Fibre Cable by provisioning in ring configuration.
• Environmental Conditions	All equipment rooms to be air-conditioned.
• Maintenance Philosophy	System to have, as far as possible, automatic switching facility to alternate routes/circuits in the event of failure. Philosophy of preventive checks of maintenance to be followed. System networked with NMS for diagnosing faults and co-ordination. Card/module level replacement shall be done in the field and repairs undertaken in the central laboratory/manufacture's premises.

x) Space Requirement for Telecom Installations

Adequate space for proper installations of all Telecommunication equipment at each of the stations has to be provided keeping in view the case of maintenance and use of instrumentation set up for regular testing and line up of the equipment/system. The areas required at each of the stations shall be generally 30 sq.m each for Telecom Room and 50 sq.m. for UPS Room (common for signal, Telecom and AFC). These areas shall also cater to local storage and space for maintenance personnel to work. At the OCC, the areas required shall be as per the final configuration of the equipment and network configuration keeping space for further expansion.

xi) Maintenance Philosophy for Telecom systems

The philosophy of continuous monitoring of system status and preventive & corrective maintenance of Telecommunication equipments shall be followed. Card / module / sub-system level replacement shall be done in the field. Maintenance personnel shall be suitably placed at intervals and they shall be trained in multidisciplinary skills. Each team shall be equipped with a fully equipped transport vehicle for effectively carrying out the maintenance from station to station.

The defective card/ module / sub-system taken out from the section shall be sent for diagnostic and repair to a centralized S&T repair lab suitably located on the section. This lab will be equipped with appropriate diagnostic and test equipments to rectify the faults and undertake minor repairs. Cards / modules / equipment requiring major repairs as specified in suppliers documents shall be sent to manufacturer's workshop.

12.2 AUTOMATIC FARE COLLECTION

11.2.1 Introduction

Metro Rail Systems handle large number of passengers. Ticket issue and fare collection play a vital role in the efficient and proper operation of the system. To achieve this objective, ticketing system shall be simple, easy to use/operate and maintain, easy on accounting facilities, capable of issuing single/multiple journey tickets, amenable for quick fare changes and require overall lesser manpower. In view of above, computer based automatic fare collection system is proposed.

For Multiple Journey, the Store Value Smart Card shall be utilized and for the Single Journey, the media shall be as utilized as Contactless Smart Token.

AFC system proves to be cheaper than semi-automatic (manual system) in long run due to reduced manpower cost for ticketing staff, reduced maintenance in comparison to paper ticket machines, overall less cost of recyclable tickets (Smart Card/Token) in comparison to paper tickets and prevention of leakage of revenue. Relative advantages of automatic fare collection system over manual system are as follows:

A) Manual fare collection systems have the following inherent disadvantages:

1. Large number of staff is required for issue and checking of tickets.
2. Change of fare structure is time consuming as has to be done at each station.
3. Manipulation possible by jamming of mechanical parts.
4. Staff and passenger interaction leading to more chances of confrontation.
5. Almost 100% ticket checking at entry / exit impossible.

B) Automatic fare collection systems have the following advantages:

1. Less number of staff required.
2. Less possibility of leakage of revenue due to automatic ticket check by control gates.
3. Recycling of ticket fraudulently by staff avoided.
4. Efficient and easy to operate, faster evacuation both in normal and emergency.
5. System is amenable for quick fare changes.
6. Management information reports generation easy.
7. System has multi-operator capabilities. Same Smart Card can be used for other applications also, including in other lines of the Metro.
8. AFC systems are the worldwide accepted systems for LRT/Metro environment.

The proposed ticketing system shall be that to be of Contactless Smart Card type for multiple journey and Token for Single Journey. The equipment for the same shall be provided at each station Counter/Booking office and at convenient locations and will be connected to a local area network with a computer in the Station Master's room.

C) Choice of Control Gates

Retractable flap type Control Gates/Paddle Type Gates are proposed which offer high throughput, require less maintenance and are latest in modern metros internationally. Tripod turnstile type gates offer less throughput and require more maintenance and hence are not proposed.

D) Passenger Operated Machine

At all stations, two Passenger Operated Machines (Automatic Ticket Vending Machines) each are proposed. The POM's will provide convenience to passengers to avoid standing in queues at ticket booths and provide them international standard service.

E) Ticket Reader/Add Value Machines

These machines will be used to know the card/token balance and can also be used as Add value device in case payment for card top up is made through alternate Internet based channel like net banking, Payment gateway etc.

12.2.2 AFC equipment Requirement

AFC equipment tentative requirement is given in Table attached. The exact number and type shall depend on the final station layout and the traffic being catered to.

12.2.3 Technology

The technology proposed for AFC systems are as under:

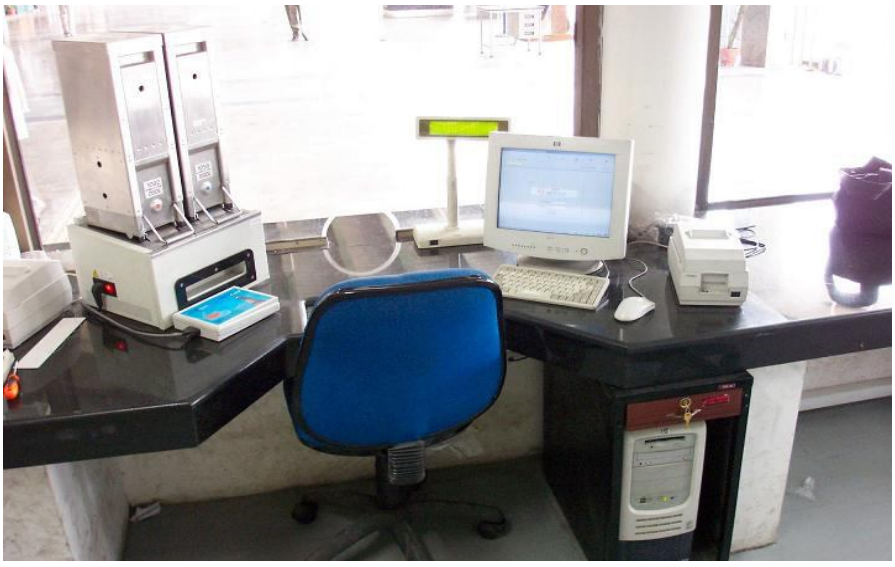
Table12.2 : Technology proposed for AFC systems

Standards	Description
• Fare media	a) Contactless smart card – For multiple journeys. It is desirable to use a card to similar specifications as being used for other Transport modes (at City or National level), so as to have future interoperability integration possible. b) Single Journey: Contactless smart token captured at exit gates.
• Gates	Computer controlled automatic gates at entry and exit. There will be following types of gates: • Entry • Exit • Reversible (if required as per final station layout) – can be set to entry or exit • Reversible Handicapped Gate -gate for disabled people.

Standards	Description
• Station computer, Central computer and AFC Net work	All the fare collection equipment shall be connected in a local area network with a station server controlling the activities of all the machines. These station servers will be linked to the central computer situated in the operational control centre through the optic fibre communication channels. The centralised control of the system shall provide real time data of earnings, passenger flow analysis, blacklisting of specified cards etc.
• Ticket office machine (TOM/EFO)	Manned Ticket office machine shall be installed in the stations for selling tickets to the passengers. Also POM's shall be provided for Automatic Ticket Vending.
• Ticket reader and portable ticket decoder.	Ticket reader shall be installed near EFO for passengers to check information stored in the ticket.
• UPS (uninterrupted power at stations as well as for OCC).	Common UPS of S&T system will be utilised.

Fig 12.1 :Entry/Exit Gates

Fig 12.2 : Ticket Office Machine



PASSENGER TRAFFIC AND REQUIREMENT OF AMENITIES IN STATIONS
(Projections for Year 2041)

Table 12.3
AMENITIES AT STATIONS
Line-1 N-S corridor (Automotive Square to Depot Station)

Station	Peak Hour Boarding and alighting in 2041	Ticketing Gates required On each side E-R-E	TOM Required	Stairs Width (m) On Each Platform	Escalators Provided At Each Station		Provision of Lifts At Each Station
					G-C	C-P	* G - P
AUTOMOTIVE SQRE	3517	2 – 2 – 2	2	4.80	2	2	**2**
NARI ROAD	1696	2 – 2 – 2	2	4.80	2	2	**2**
INDORA CHOWK	1366	2 - 2- 2	2	4.80	2	2	**2**
KADVI CHOWK	1469	2 – 2 – 2	2	4.80	2	2	**2**
GADDI GODAM SQRE	282	2 – 2 – 2	2	4.80	2	2	**2**
KASTURCHAND PARK	1947	2 – 2 – 2	2	4.80	2	2	**2**
ZERO MILE	1161	2 – 2 – 2	2	4.80	2	2	**2**
SITABURDI	5185	4 – 4 – 4	3	4.80	2	8	**2**
CONGRESS NAGAR	5869	4 – 4 – 4	4	4.80	2	2	**2**
RAHATE COLONY	1485	2 – 2 – 2	2	4.80	2	2	**2**
AJNI SQUARE	927	2 – 2 – 2	2	4.80	2	2	**2**
CHHATRAPATI SQUARE	521	2 – 2 – 2	2	4.80	2	2	**2**
JAIPRAKASH NAGAR	347	2 - 2- 2	2	4.80	2	2	**2**
UJWAL NAGAR	524	2 - 2- 2	2	4.80	2	2	**2**
AIRPORT	290	2 - 2- 2	2	6.00	2	2	**2**
NEW AIRPORT	1058	2 - 2- 2	2	4.80	2	2	**2**
KHAPARI	2905	2 – 2 - 2	2	4.80	2	2	2

Note: G- Ground/ street level,
C- Passage level,
P- Platform
** -Interchange station*

Table 12.4
AMENITIES AT STATIONS
Line-2 E-W corridor (Prajapati Nagar to Lokmanya Nagar)

Station	Peak Hour Boarding and alighting in 2041	Ticketing Gates required On each side E-R-E	TOM Required.	Stairs Width (m) On Each latform	Escalators Provided At Each Station		Provision of Lifts At Each Station
					G-C	C-P	* G - P
1. Prajapati Nagar	498	2 - 2- 2	2	6.40	2	2	**2**
2. Vaishnodevi Chowk	458	2 - 2- 2	2	4.80	2	2	**2**
3. Ambedkar Chowk	520	2 - 2- 2	2	4.80	2	2	**2**
4. Telephone Exchange	2066	2 - 2- 2	2	4.80	2	2	**2**
5. Chittar oli Chowk	1611	2 - 2- 2	2	4.80	2	2	**2**
6. Agarsen Chowk	1028	2 - 2- 2	2	4.80	2	2	**2**
7. Dosar Vaisyan Chowk	1155	2 - 2- 2	2	4.80	2	2	**2**
8. Nagpur Railway Station	4460	2 - 2- 2	6	4.80	2	2	**2**
9. Sitaburdi	3839	4 – 4 – 4	7	4.80	2	2	**2**
10. Jhansi Rani Square	2969	4 – 4 – 4	3	8.00	2	2	**2**
11. Institute of Engineers	3492	2 - 2- 2	3	4.80	2	2	**2**
12. Shankar Nagar Square	2814	2 - 2- 2	2	4.80	2	2	**2**
13. Lad Chowk	565	2 - 2- 2	2	4.80	2	2	**2**
14 Dharampeth College	1634	2 - 2- 2	2	4.80	2	2	**2**
15 Subhash Nagar	315	2 - 2- 2	2	4.80	2	2	**2**
16 Rachna (Ring Road Jn.)	423	2 - 2- 2	2	4.80	2	2	**2**
17 Vasdev Nagar	819	2 - 2- 2	2	4.80	2	2	**2**
18 Bansi Nagar	534	2 - 2- 2	2	4.80	2	2	**2**
19 Lokmanya Nagar	1513	2 - 2- 2	2	4.80	2	2	**2**

Assumptions:
1. Each station has only 2 access
2. Minimum AFC equipments at a station with "2 access- 1 for entry, 1 for exit": 2 entry gates, 2 exit gates, 2 EFO, 2 TOM, 4 TR,2 TVM
3. One Disabled gate at each station.
4. Throughput of gate 25 passengers per minute, TOM 10 transactions per minutes.
5. 50 % passenger are assumed on Smart Card and 50% on single journey token.