An Introductory Handbook on Centralized Traffic Control (CTC)

End Users: S&T Engineers of Indian Railways

CAMTECH/S/PROJ/2021-22/CTC/1.0, February 2022

Maharajpur, Gwalior (M.P.) – 474005
सेंट्रलाइज्ड ट्रैफिक कंट्रोल (सी.टी.सी.)
पर एक परिचयात्मक हस्तपुस्तिका

An Introductory Handbook on
Centralized Traffic Control (CTC)

अंतिम उपयोगकर्ता : भारतीय रेलवे के एस एंड टी इंजीनियर
End Users : S&T Engineers of Indian Railways
कैमटेक/एस/प्रोज/2021-22/सीटीसी/1.0
CAMTECH/S/PROJ/2021-22/CTC/1.0
फरवरी 2022
February 2022
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Foreword

The history of development of Centralized Traffic Control (CTC) in Indian Railways starts way back in 1966 when it was first commissioned on Gorakhpur-Chhapra section of North Eastern Railway. Since then there were technological advancements in the area of railway signalling and telecommunications. The latest installations of CTC are equipped with modern signalling assets like electronic interlocking and communications media like Optic Fibre Communication Cable. With CTC, Centralized control & supervision of a large section can be performed. CTC operator of particular territory can operate all the signals, points, routes of any station of his territory from a remote location. However there are still challenges ahead to make CTC installations fully operational, due to Traffic department issues, issues due to prevalent General & Subsidiary rules and technical issues like interfacing of CTC with different interlocking systems. These challenges can be overcome by learning through the experience gained from the earlier installations and applying it for improvising in new installations. In Indian Railway as more CTC installations are in the pipeline, CAMTECH has issued this introductory handbook for dissemination of information on basics of Centralized Traffic Control, its infrastructure requirements and lessons learnt from previous installations.

I hope that this handbook will prove to be helpful to the S&T officials in understanding the concepts of Centralized Traffic Control.

CAMTECH Gwalior

Jitendra Singh
Principal Executive Director
Preface

The CTC or Centralized Traffic Control system caters for centralized control & supervision of train operation. The CTC is a state of art computer based system which facilitates the train control and management of multiple Signalling interlocked region from a single location. Due to centralized control & supervision of a large section, it has several advantages like Better Line capacity management, automatic route setting, Time Table Management, advance planning of path, better disaster management etc. Indian Railways have gained new experience, by commissioning CTC installations like CTC Tundla (Kanpur-Ghaziabad Section) in North Central Railway and CTC Bhadrak - Dhamra Port link in East Coast Railway with Electronic Interlocking.

The objective of this handbook is to provide information on basics of Centralized Traffic Control system and its functionalities and infrastructure requirements as per RDSO specifications. To cover experience gained and challenges ahead a section on CTC at Tundla, N.C.Rly.is also added.

We are sincerely thankful to Shri Vijay Malviya, Professor (S&T) NAIR, Vadodara, Signal Directorate RDSO, and North Central Railway who have provided valuable inputs for preparing this handbook. Since technological upgradation and learning is a continuous process, you may feel the need for some addition/modification in this handbook. If so, please give your comments on email address dirsntcamtech@gmail.com or write to us at Indian Railways Centre for Advanced Maintenance Technology, In front of Adityaz Hotel, Airport Road, Near DD Nagar, Maharajpur, Gwalior (M.P.) 474005.

CAMTECH Gwalior                      Navneet Kumar Varma
Director (S&T)
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Disclaimer & Objective

Disclaimer

It is clarified that the information given in this handbook does not supersede any existing provisions laid down in the Signal Engineering Manual, Railway Board and RDSO publications. This document is not statutory and instructions given are for the purpose of guidance only. If at any point contradiction is observed, then Signal Engineering Manual, Telecom Engineering Manual, Railway Board/RDSO guidelines may be referred or prevalent Zonal Railways instructions may be followed.

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To upgrade Maintenance Technologies and Methodologies and achieve improvement in Productivity and Performance of all Railway assets and manpower which inter-alia would cover Reliability, Availability and Utilisation.

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Phone : 0751 - 2470185
Fax : 0751 – 2470841
Email : dirsntcamtech@gmail.com
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CAMTECH is continuing its efforts in the documentation and up-gradation of information on maintenance practices of Signalling & Telecom assets. Over the years a large number of publications on Signalling & Telecom subjects have been prepared in the form of handbooks, pocket books, pamphlets and video films. These publications have been uploaded on the internet as well as railnet.
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https://rdso.indianrailways.gov.in/view_section.jsp?lang=0&id=0,2,17,6313,6321,6326

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Go to Directorates → CAMTECH → Publications → S&T Engineering
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*Write at*
*Director (S&T)*
*Indian Railways Centre for Advanced Maintenance Technology,*
*In front of Hotel Adityaz, Airport Road, Maharajpur,*
*Gwalior (M.P.) 474005*
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# Abbreviations

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<td>AC</td>
<td>Alternating Current</td>
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<tr>
<td>ARS</td>
<td>Automatic Route Setting</td>
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<td>ASM</td>
<td>Assistant Station Manager</td>
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<td>AT</td>
<td>Auxiliary Transformer</td>
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<td>ATP</td>
<td>Automatic Train Protection</td>
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<td>BCC</td>
<td>Backup Control Centre</td>
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<td>CA</td>
<td>Central Announcement</td>
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<td>CCTV</td>
<td>Closed Circuit Television</td>
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<td>CMS</td>
<td>Crew Management System</td>
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<td>CNB</td>
<td>Kanpur</td>
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<td>COA</td>
<td>Control Office Application</td>
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<td>COIS</td>
<td>Coaching Operations Information System</td>
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<td>CR</td>
<td>Central Railway</td>
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<td>CSMT</td>
<td>Chhatrapati Shivaji Maharaj Terminus</td>
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<td>CTC</td>
<td>Centralized Traffic Control</td>
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<tr>
<td>CRC</td>
<td>Cyclic Redundancy Check</td>
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<td>CRS</td>
<td>Commissioner of Railway Safety</td>
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<td>CSR</td>
<td>Clear Standing Room</td>
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<td>DG</td>
<td>Diesel Generator</td>
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<td>DSS</td>
<td>Decision Support System</td>
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<td>ECoR</td>
<td>East Coast Railway</td>
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<td>EI</td>
<td>Electronic Interlocking</td>
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<td>ETCS</td>
<td>European Train Control System</td>
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<td>E-TSR</td>
<td>Electronic Temporary Speed Restriction</td>
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<td>FDD</td>
<td>Frequency Division Duplex</td>
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<td>FIU</td>
<td>Field Interface Unit</td>
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<td>FOB</td>
<td>Foot Over Bridge</td>
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<td>FOIS</td>
<td>Freight Operations Information System</td>
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<td>FRS</td>
<td>Functional Requirement Specification</td>
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<td>G&amp;SR</td>
<td>General &amp; Subsidiary Rules</td>
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<td>GPS</td>
<td>Global Positioning System</td>
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<td>GR</td>
<td>General Rules</td>
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<td>GSM-R</td>
<td>Global System for Mobile Communication-Railway</td>
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<td>GZB</td>
<td>Ghaziabad</td>
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<td>Hz</td>
<td>Hertz</td>
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<td>IBS</td>
<td>Intermediate Block Signalling</td>
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<td>ID</td>
<td>Identification</td>
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<tr>
<td>IEC</td>
<td>International Electro-technical Commission</td>
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<td>IP</td>
<td>Internet Protocol</td>
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<td>IRATP</td>
<td>Indian Railways Automatic Train Protection</td>
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<td>ISDN</td>
<td>Integrated Services Digital Network</td>
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<td>JPO</td>
<td>Joint Procedure Order</td>
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<td>KVA</td>
<td>Kilovolt Ampere</td>
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<td>KYN</td>
<td>Kalyan Junction</td>
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<td>LAN</td>
<td>Local Area Network</td>
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<td>LC</td>
<td>Level Crossing</td>
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<td>LCD</td>
<td>Liquid Crystal Display</td>
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<td>LCP</td>
<td>Local Control Panel</td>
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<td>LED</td>
<td>Light Emitting Diode</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>MIS</td>
<td>Management Information System</td>
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<td>MMI</td>
<td>Man Machine Interface</td>
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<td>MPLS</td>
<td>Multi-Protocol Layering Switch</td>
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<td>MPP</td>
<td>Microlok Peripheral Post</td>
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<td>MTRC</td>
<td>Mobile Train Radio Communication</td>
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<td>NCC</td>
<td>National Control Centre</td>
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<td>NCR</td>
<td>North Central Railway</td>
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<td>NDLS</td>
<td>New Delhi Railway Station</td>
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<td>NTES</td>
<td>National Train Enquiry System</td>
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<tr>
<td>OCC</td>
<td>Operation Control Centre</td>
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<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
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<td>OFC</td>
<td>Optic Fiber Communication</td>
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<td>OHE</td>
<td>Overhead Equipment</td>
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<tr>
<td>PA</td>
<td>Public Address</td>
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<tr>
<td>PC</td>
<td>Personal Computer</td>
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<tr>
<td>PCSTE</td>
<td>Principal Chief Signal &amp; Telecom Engineer</td>
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<tr>
<td>PI</td>
<td>Panel Interlocking</td>
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<td>RCE</td>
<td>Recording of Chronological Events</td>
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<td>RDSO</td>
<td>Research Designs &amp; Standards Organisation</td>
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<td>RRI</td>
<td>Route Relay Interlocking</td>
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<tr>
<td>S&amp;D</td>
<td>Service &amp; Diagnostic</td>
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<tr>
<td>S&amp;T</td>
<td>Signal &amp; Telecommunications</td>
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<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
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<tr>
<td>SEM</td>
<td>Signal Engineering Manual</td>
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<tr>
<td>SM</td>
<td>Station Manager</td>
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<td>SMS</td>
<td>Short Message Service</td>
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<td>SRS</td>
<td>System Requirement Specification</td>
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<td>Sr DOM</td>
<td>Senior Divisional Operating Manager</td>
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<td>SSBPAC</td>
<td>Solid State Block Proving by Axle Counter</td>
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<tr>
<td>TCAS</td>
<td>Train Collision Avoidance System</td>
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<td>TDL</td>
<td>Tundla</td>
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<td>TDS</td>
<td>Train Describer System</td>
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<td>TMS</td>
<td>Train Management System</td>
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<tr>
<td>TT</td>
<td>Transformer Neutral Earthed and Frame earthed configuration</td>
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<td>TWRD</td>
<td>Traffic Working Rule Diagram</td>
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<tr>
<td>UFSBI</td>
<td>Universal Fail Safe Block Interface</td>
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<tr>
<td>UIC</td>
<td>International Railway Union</td>
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<tr>
<td>UPS</td>
<td>Uninterrupted Power Supply</td>
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<tr>
<td>VDU</td>
<td>Visual Display Unit</td>
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<td>WAN</td>
<td>Wide Area Network</td>
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<tr>
<td>WMS</td>
<td>Wagon Management System</td>
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Section I
Centralized Traffic Control

1.1 Introduction
Centralized traffic control (CTC) is a form of railway signalling that consolidates train routing decisions unlike in existing absolute block signalling where these are carried out by local station masters on instructions of Train Controllers. The system consists of a centralized train dispatcher that controls wayside station interlockings and traffic flows in portions of the section designated as CTC territory. One more distinctive feature of CTC is a control panel with a graphical depiction of the section. Larger sections may have multiple dispatcher's offices and even multiple dispatchers for each operating division. These offices are usually located near the busiest yards or stations.

1.2 History of development
The CTC system was first developed by the General Railway Signal company as their trademarked "Centralized Traffic Control" technology. Its first installation in 1927 was on a 40-mile stretch of the New York Central Railroad between Stanley and Berwick, Ohio, with the CTC control machine located at Fostoria, Ohio. CTC was designed to enable the train dispatcher to control train movements directly, bypassing local operators and eliminating written train orders. Instead, the train dispatcher could directly see the trains' locations and efficiently control the train's movements by displaying signals and controlling switches. It was also designed to
Centralized Traffic Control

February 2022

enhance safety by reporting any track occupancy to a human operator and automatically preventing trains from entering a track against the established flow of traffic. More number of CTCs were installed in Australia, New Zealand and United States in the subsequent years.

In Indian Railways, the first CTC installations were commissioned on 180 Km Gorakhpur-Chhapra section of North Eastern Railway and 156 Km New Bongaigaon- Guwahati section of North Frontier Railway in 1966 and 1967 respectively. However both of these CTCs were on single line meter guage sections. Hence the experience with CTC was limited to these sections only. After a gap of about four decades, two more CTCs became functional namely Bhadrak – Dhamra Rail Line (61 Km) on ECoR in 2011 and Ghaziabad – Kanpur Section (400 Km) on NCR in 2019. Some other modified versions of CTC have been installed at NDLS, Churchgate-Virar Section of WR and CSMT-KYN section of CR. These installations were new experiences for Indian Railways as the new CTCs are commissioned with modern assets like Electronic Interlocking, Automatic Signalling, Electronic Block Working, OFC, CCTV etc. Although these CTCs are functional, there are still some challenges being faced for making them operational. More CTC installations may come in future for which lessons from earlier installations will be useful. CTC shall conform to draft RDSO specification No. RDSO/SPN/212/2012 Ver. 2.0 or latest.

1.3 Benefits of CTC

- Centralized control & supervision of a large section. Better Line capacity management
- Operator can set the long routes within a territory with a single command.
- Time Table Management.
- Train Describer System (Train ID) Management.
- Automatic generation of Train Graphs: advance planning of path and plan movement of unscheduled trains.
- Other controllers can see status of section without disturbing the section controller (Panoramic projection system/Wall display).
- Playback for a large section is possible.
- Fault management control from a central location.
- Better disaster management
1.4 **CTC Functions**

The CTC or Centralized Traffic Control system caters for centralized control & supervision of train operation. The CTC is a state of art computer based system which facilitates the train control and management of multiple Signalling interlocked region from a single location. The Computer Based Interlocking gathers the required static and dynamic information from the track side signalling gears and sends it to Central server(s) located at a distant location by means of optical fiber or radio or any other communication medium. This information is then processed by Central server(s) and then catered to various MMIs or panoramic projection system to provide the real time simulation of railway traffic on the tracks.

1.5 **Train Management System (TMS)**

(Ref.: SEM Section 4, Para 13.4.1)

Train Management System broadly carries out following functions:

(a) Centralized Operation of Signalling Systems for a large section encompassing multiple interlocked stations and LC gates.

(b) Centralized Real Time Monitoring of Train Traffic for enabling efficient decision making

(c) Interfacing & real time data sharing with COA (Control Office Application), Crew management system, PA system at station,
(d) TMS should have facility of Automatic route setting (ARS), Long route setting, Route stacking command for avoiding repetitive operation by controller.

(e) The system shall be able to generate various MIS report, train graph and detect and manage alarms and logs generated in the system.

Note: CTC (Centralised Traffic Control) system caters for centralised control & supervision of train operation whereas TMS system comprises of CTC system as well as other management tools like MIS report, time tabling, asset monitoring, interfaces with COA, ATP system, crew management & passenger information system etc. CTC is a sub set of TMS.

1.5.1 Functionalities of TMS
(Ref.: SEM Section 4, Para 13.4.2)

The system broadly envisages the functionality as described below:

(a) **Live Indications - Visual display wall:**
This displays track layouts of stations, auto sections, IBS and interlocked LC Gates of section monitored by TMS indicating real-time status of track circuited lines, signal aspects, points, LC Gate etc. The panel will also provide alarm indications of failure of points, signals, track circuits etc. as the case may be.

![Figure 4: Actual view of wall display](image-url)
(b) **Live Indication to Train controller terminals:**

(i) These consist of LCD/LED monitors operated by one computer with GPU (Graphic Processing Unit).

(ii) All terminals shall be able to display complete information of yards covered by TMS with details of track circuits, signals, Points, LC gates etc. Any failure of signalling system on any of yard will be available in audio & visual form to draw attention of controller.

(iii) The train controller terminal is capable of running the Decision Support System (DSS) feature. Decision support system identifies operational conflicts (like precedence, crossing etc.) in advance and suggests optimized control options to the controller.

(iv) Live Indications on terminals provided with staff at Important Junction stations/Car shed/lobbies may be provided, as required.

*Figure 5 : Sketch showing CTC System – 6 Controller Desks and One Chief Controller with Wall Display*
(c) **Train Describer System (TDS):**

(i) It associates a train with an alpha-numeric mark called a train describer tag.

(ii) The train description tag tracks the train in sections controlled by TDS.

(iii) The train describer system automatically assigns train describer tags from a train number queue to trains originating/terminating at the stations covered by TDS based on time table.

(iv) The train describer system registers & displays abnormal conditions such as following:

- Single track circuit failure.
- Faulty position of points.
- Change in direction of a train.
- Division and joining of trains (not time tabled ones).
- Unidentified trains.
- Trains passing a signal showing a stop aspect.
- More trains on the same track circuit.
- Wrong marking of object/functions. (For example-A train with electric loco being marked onto non-electrified line, A passenger train marked to a goods line, A train being routed to wrong destination etc.).

(v) Abnormal disappearing of train describer tag shall generate an alarm and display in different colour.

(d) **Control Function:**

After taking control of an area, the central controller will be able to send commands to the corresponding interlocking. The possible commands are:

(i) Setting/cancellation of route.

(ii) Moving point to Normal or Reverse.

(iii) Controlling signal (ON/OFF) as permitted by interlocking.

(iv) Setting/cancellation of traffic & power block.

(v) Turning the ARS mode ON/OFF, long route setting & route stacking.

(vi) Loading of Timetable/Train Chart.

(e) **Automatic Route Setting (ARS):**

(i) The automatic route setting feature will be possible to be provided for identified stations/routes/sections.
(ii) The ARS system relieves the operator from repetitive route setting tasks for the trains at these stations and the operator can monitor the train operation from OCC (Operation Control Centre). The system shall execute the commands according to timetable.

Note: Advance Route setting of more than one train at a time can be done. No individual route setting is required. This is useful for giving precedence to trains.

(f) Long Route Setting & Route Stacking:
(Setting of route between two different stations by a single command)
The chief controller/section controller in OCC can set long route for one station to another station. Provision of Route stacking shall be made to set routes of multiple trains in advance.

(g) Block Working Operation:
(i) Block Operation for EI station will be done through CTC controller from OCC. Suitable failsafe provision of inbuilt block operation system in EI is needed for this and Conventional block instrument/panel may not be used for block operation. In case inbuilt block working in EI is not available, local operation of block instrument will be done by SM at station.

(ii) For PI/RRI stations operation of block instruments/block panel may be required to be done by SM at station.

Note:
At PI/RRI Stations local/CTC operation, shall be executed through either by using SSBPAC or UFSBI block working concept on need basis.

1.5.2 Management Information System (MIS)
(Ref.: SEM Section 4, Para 13.4.3)

(a) MIS Reports
The system will generate report for trains run delayed by time table. Based on the events logged and the operator input, the system will generate various traffic management reports such as:

(i) Various Train control charts.

(ii) Various Punctuality reports.

(iii) Actual Rake Link Report.

(iv) Rake Composition report.

(v) Rake Maintenance/overhauling reports.
(vi) Analytical report of various unusual occurrences, i.e. signal failures, OHE breakdown, rake failure etc. (This may be generated on daily, weekly or monthly basis on prescribed format.)

(vii) Analytical report of crew link/utilization.

(viii) Analytical report on rake link utilization.

(ix) Total traffic/power blocks granted/refused along with locations, time blocked, time cleared.

(x) Any other analytical report as required.

(b) Train Graph
The train graph will be made available on the specified terminals. This broadly has following features:

(i) The system will plot historical train graph for analysis.

(ii) It will plot time on X axis and stations on Y axis.

(iii) The train graph will have facility to show different train types in different color. It shall be possible to show schedule time and the actual time in the same graph but with different colour.

Figure 6: CTC Electronic Train Graph (Time Line Chart)
(iv) It will be possible to show mainline trains/Suburban/Goods/Special trains in different colour.

(v) On clicking/selecting a particular Train Graph it will give complete information about the train details viz. train no, crew information, rake details etc.

(vi) Advance charting: In case controller defines the traffic block on particular line for particular time, system will be able to prepare train graph showing advance/predictive movements of available trains in particular section in different colours.

(vii) It will be possible to edit the timetable graphically from the Train Graph display by drag and drop operations.

(viii) The Timetable software will automatically perform the re-forecasting of the future train trips when modifications are being performed either by the operator or due to traffic perturbations.

(ix) The Train Distance Graph will highlight traffic conflicts and will assist the regulator in identifying and implementing solutions to resolve conflict situation like - Same platform use.

1.5.3 Simulation Studies on Simulation terminal
(Ref.: SEM Section 4, Para 13.4.4)
Separate terminal may be provided for simulation studies & training purpose. The replay of log, time table editing, editing of train graph etc. will be provided on this terminal.

1.5.4 Time Table Builder and Editing
(Ref.: SEM Section 4, Para 13.4.5)
Based on data base of infrastructure like signal distances, permitted speed of trains, Signal interlocking, track circuit lengths etc. required for generation of time table, time table builder, an off-line software, will prepare a time table. Time table so generated can be modified/edited offline and after testing of same on simulator terminal, can be loaded on the Train Describer System.
1.5.5 Event Log and Alarm Management System
(Ref.: SEM Section 4, Para 13.4.6)

(a) **Event Log**: All important events (command, indications, errors, system information etc.) will be logged in a database for later printing and analysis.

(b) **Replay of Event Log**: The replay function will show an history of events that has happened earlier in the TDS system. The replay function will display, among other details, the dynamic status for infrastructure, train number and alarm list.

(c) **Traffic Related Alarms**: Vital traffic operation related alarms can be
   (i) Train not described.
   (ii) Any unscheduled Train stoppage.
   (iii) Routes not released after passage of train.
   (iv) Failure of Signalling gear.

(d) **Network Related Alarms**: All alarms not directly related to traffic operations are considered to be Network related alarms. Failure of Network Communication/inability to access any of the nodes, defective terminals, and hardware & software failures will be flashed.

1.5.6 Decision Support System (DSS)
(Ref.: SEM Section 4, Para 13.4.7)

(a) Based on the constraints & logic given by Railways, system will give optimized decision to admit or dispatch particular train at entry/exit points of a particular section.

(b) **Train running at the time of disruption**: System will suggest effect of disruption on train service. Based on constraints, facilities & logic provided by railways, system will give solution for running of trains, diversion, cancellation or regulation of train services.

(c) System will be able to detect conflicts like:
   (i) Usage of the same platform;
   (ii) Usage of the same routes;
   (iii) Usage of incompatible routes;
   (iv) Usage of the same section and same directions;
   (v) Usage of the same section and opposite directions.

(d) In case of conflicts, TMS display a specific icon on the train graph and generates a solution which consists in the rescheduling of the involved activities.
1.6 **Field Interface Unit (FIU)**
- This unit will interface with the potential free contacts in Signal Equipment Room and extend data to/ from PI/RRI Interlocking.
- The RRI/PI station’s and independent LC gates signalling field gear data shall be fetched through FIU using potential free contacts.
- System to be used for communication with interlocking shall be as per IEC 870-5-101 communication protocol.
- The FIU system design shall ensure that SIL2 level is maintained during communication between CTC and FIU.
- In case of failure FIU control shall be automatically transferred to Station Master at station.
- For interfacing of EI with CTC, protocol converter shall designed by CTC vendors. Data protocol used for EI may be shared by EI vendors.

1.7 **Backup Control Center (BCC)**
- A Backup Control Centre (BCC) will be provided at designated place to take over controls in case of exigencies/breakdown as a Disaster Management Plan.
- In case of exigencies/breakdown at OCC the control of OCC shall be transferred to BCC seamlessly such that all functionality of OCC shall be achieved through BCC.
- BCC should use independent system resource, in case failure of OCC due to failure of any subsystem of OCC, the working of BCC should not get affected.
- The communication channel from station to BCC shall be different from that of OCC as far as possible.

1.8 **National Control Centre (NCC)**
- Provision of national control centre shall be made to monitor zonal CTC system & to take over control of any CTC system under its jurisdiction.
- Transfer of control can also be extended through BCC so that in case of non functioning of OCC it is possible to monitor and control CTC from NCC.
- Connectivity between CTC and NCC should be on high bandwidth MPLS network or any better system to maintain all functionalities of OCC from NCC.
- Redundancy in communication network shall also be planned.
- All the functionalities of OCC should be made available on NCC.
• Provision of NCC is required to be made for once with first CTC and all future CTC shall be networked to that NCC.

1.9 Technical Requirements of TMS
• All Servers and Terminals to be provided at OCC shall be of same type and make as approved by the Engineer.
• All Terminals to be provided at wayside locations shall be of same type and make as approved by the Engineer. The hardware installed at wayside locations shall be modular and rugged and of appropriate size, capability and capacity.
• All Servers and Terminals at OCC & wayside locations shall be provided with printer slot and minimum 2 spare slots for future use.
• Servers and Terminals shall be of Industrial grade. Vendor of Servers and terminals shall have service centers in India.
• LED Indications and test points shall be available on various cards Modules for easy fault diagnostics by the maintenance personnel.
• The system designed and implemented shall be flexible and modular enough to permit easy alterations in terms of change in site data, addition or deletion of user, stations etc.
• The TMS shall support communication with neighboring TMS based on UIC 407-1 or similar standards.

1.10 Video Display System

Video Wall Display
Laser based rear projection system type video wall may be used. It shall consist of Display modules and Display Controller which will integrate various display modules into a single logical Display Wall.

Display Controller
The Display controller shall be dual redundant with auto switchover including dual redundant hot swappable power supply.

The Display controller shall have the possibility of connecting the various types of analog and digital sources which can be shown in freely scalable and moveable windows on the graphics wall.
Design of display controller shall fulfill all functionality, reliability and availability requirements as specified.

**Wall Management Software**
The Wall Management software shall provide control and management of application windows and display devices connected with the display controller. It shall be able to pre configure various display layouts and access them at any time with a simple mouse click.

### 1.11 CTC Terminals
For standard monitoring, supervision and control purposes all operator interfaces to the CTC system should be through universal type of workstations (CTC terminals) which can be easily configured to required operator functionality based on the users log in profile. Irrespective of whatever may be the operational role of user, the CTC terminals shall have the same look and feel to maximize the operational synergies between the various operator roles. All the CTC terminals shall show the real time display of train movements and status of signalling infrastructure. Various TMS Terminals may be provided, as required, as under:

**CTC Terminals for Controllers - Chief Controller, Dy. Chief Controller, Traffic Controller(s) and Assistant Traffic Controller**
These CTC terminals with each of the Controller shall have three monitors, one will show the overview, another detailed view and the third one would show the alarm/event view. There shall be full flexibility, however with regard to display of information on any of the 3 monitors.

CTC Terminal shall facilitate all functions of Train Describer System.

All the Traffic related alarms shall be available on these terminals

**CTC Terminal for Signal Fault Controller at OCC**
Remote monitoring of status of Signalling equipment at stations and in Block Sections will be provided on these terminals. This will include logging in of events in central system, generating alarms, alerts etc. Signalling equipment failure alarms as decided by the Engineer along with category will be available on the terminal. It will be possible to acknowledge the alarms by the user.
CTC Terminals for Track Controller and Traction Power Controller at OCC
Equipment failure alarms specific to Track or Traction Power, as decided by the Engineer along with category will be available on the respective terminals. It will be possible to input remarks/Information pertaining to various unusual occurrences e.g. failures & delays to operation etc.

CTC Maintenance Terminal at OCC
The Maintenance Terminal will be used for supervisory functions of the network and for observing any required nodes and their configuration at any time. Displays of equipment faults, communication failure occurring anywhere in the OCC or field network will be available. Failure alarms will also be given. It will be possible to bypass any node if so required and configure other terminals from this terminal.

CTC Terminal for Station Master at Station
One CTC Terminal for Station Master at every Station shall be provided.
CTC Terminal for Station Master shall facilitate all functions of Train Describer System.

CTC Terminal with Signal Maintainer at Station
The alarms for failure of vital Signalling and Power Supply Equipment in the jurisdiction of Station will be available on the terminal.

Miscellaneous User Terminal
Required Nos. of Miscellaneous User TMS Terminals to important offices/locations will be provided. The locations may be station, Divisional and Zonal office as decided by the Railway. These terminals will provide first-hand information about running of trains in visual form and in the required format.

1.12 Interface Requirements
Various interface/integration Requirements may be as given below:
(a) Interface between CTC and SCADA system.
(c) Interface with Master Clock System.
(d) Interface with COA.
(e) Interface with other CTC, if any.
(f) Interfaces with Passenger Information System which shall cover:
   (i) PIS System
   (ii) Indicator Boards on Platforms & FOBs
(iii). VDU monitors at Stations
(iv). Central Announcement (CA) system and way side station announcement system
(v). Additional Passenger information system (PIS) information on ASM PC

(g) Interface with ETCS L-2/IRATP (TCAS)

1.13 Communication Network

Communication network at OCC
Dedicated Communication Network at OCC for interconnection of CTC Equipment (Servers, Terminals, Video Wall Systems, Data Storage, Printers etc.) shall be fault tolerant.

Networking Equipment used in Communication Network such as Bridges, Gateways, Routers, Switches and Repeaters shall have redundancy. The local area network employed shall be Dual LAN Network based on FDD/Ethernet/Serial communication.

Dual redundant link shall provide highly resilient communications network. System shall be tolerant to multiple simultaneous link failures, maintaining operation without degradation of performance. It shall be possible to perform maintenance on communication links without stopping the Signalling system. Data transfer to peripherals like printers & plotters can be at lower speed for each device using appropriate media with duplicate path. For connecting peripherals, screened twisted pair cables shall be used.

Data Communication network between CTC & Field interlocking system
Dedicated OFC network in ring network shall be used for interconnecting field interlocking system with CTC. 100% redundancy in design shall be planned. Protection of this network may also be planned through hired channel from Railnet or other service provider. Preferably Multi-Protocol Layering Switch (MPLS) data transport protocols shall be used for better resource sharing. WAN network shall be used for networking of field functions like Freight Operations Information System (FOIS), Crew Management System (CMS), Wagon Management System (WMS).

Wayside Communication Equipment
Integrated digital communication shall be provided covering all field nodes (Station, Hut, LC gate etc). It should be based on client-server technology on IP platform. Facility of Voice logging shall also be made. OFC should be used for media.
**Integration with Mobile Train Radio (MTRC) System (optional)**
A Mobile communication may be available between the motorman/Loco pilot/guard & the section controller. TDS shall send the Train ID/rake details file for auto registration of Mobile cab radio. It shall be possible to send the emergency caution order in the form of SMS through his TDS/ MTRC terminal. It shall be possible to generate SMS message for the drivers of trains stating name of next halt station for that particular train. This SMS message shall be transmitted by MTRC terminal.

**1.14 Power Supply**
The CTC system in OCC shall be provided with UPS of suitable capacity based on the load requirement at OCC. Power supply units of all modules shall be operated from AC source ranging from 160 to 270 Volts (with tolerance of +10 V), 50 Hz AC, single phase with over voltage, under voltage and short circuit protection.

**1.15 Lightning and Surge Protection for Electronic Signalling Equipments**
The equipment shall be suitably protected against atmospheric voltage surges both for common mode (voltage that appears between phase conductors and earth) and differential mode (voltage that appears between neutral & earth) in order to limit the harmful effects of lightning.
The power line of electronic signalling equipment shall have Class B & C type 2-stage protection in TT configuration. Stage 3 protection is also required for protection of power/signalling/data lines. Class B & class C type protection devices shall preferably be pluggable type to facilitate easy replacement.
Section II
CTC Tundla- An overview

2.1 Introduction

Contract for CTC Tundla was Awarded to M/s Ansaldo (Hitachi) on 1.2.2006 as a part of KfW Project for Modernization of Signalling and Telecommunication in Kanpur-Ghaziabad Section of Allahabad Division of North Central Railway. The CTC Tundla is divided into 6 different territories each controlled by a CTC controller. Presently as per the CTC territory Plan submitted the Tundla Station and big yards as decided by Railways will not be under CTC and will be operated locally. The Territory Division has been done considering the number of routes, amount of traffic to be managed by a CTC Controller.

![Figure 7: Route map of CTC Tundla between CNB-GZB section](image)

- Total no. of CTC manageable stations: 44
- No. of stations commissioned and live on CTC: 30 (Aligarh Kanpur Section)
CTC Tundla covers the full TDL control 03 boards (GZB board, Area board & CNB board) by 06 territories i.e. T1, T2, T3, T4, T5 & T6 covering 47 stations with total route km of 393.89 km. The full track Km of this section is automatic signalling with the last commissioning of TDL yard on 20.10.2019. The first station connected with CTC on 23.03.2015 was Hirangaon.

CTC TDL right now is commissioned between Aligarh (Ex) to Panki (Ex), which are part of present Area Board and Kanpur Board of TDL control. In CTC they are divided into four territories i.e. T1, T2, T3 and T4. This is covering total Route Km of 280 km.

**Break Up of CTC Territory**

<table>
<thead>
<tr>
<th>Existing Boards</th>
<th>CTC Territory</th>
<th>Station</th>
<th>Total Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNB BOARD</td>
<td>T1</td>
<td>BPU, MTO, RRH, AAP, JJK, KNS &amp; PHD</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>PTX, ULD, SHW, BNT, EKL, ETW, SB &amp; JGR</td>
<td>8</td>
</tr>
<tr>
<td>CNB BOARD + AREA BOARD</td>
<td>T3</td>
<td>BBL, BDN, KAA, SKB, MNR, FZD &amp; HNG</td>
<td>7</td>
</tr>
<tr>
<td>AREA BOARD + GZB BOARD</td>
<td>T4</td>
<td>MTI, BRN, CMR, JLS, PRA, HRS, SNS, MXK, DAQ &amp; ALJN</td>
<td>10</td>
</tr>
<tr>
<td>GZB BOARD</td>
<td>T5</td>
<td>MWUE, KLA, SOM, DAR, KRJ, SKQ &amp; CHL</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>T6</td>
<td>WIR, DKDE, AJR &amp; MIU</td>
<td>4</td>
</tr>
</tbody>
</table>

*Figure 8: Hirangaon - The first station connected with CTC*
2.2 Present procedure of operation with CTC

- COA controller does the planning and gives instructions to CTC operators

- CTC operators communicate with ASM and Level Crossing gateman regarding train operation.

- CTC Operator does the train operation for respective territories (6-8 stations) i.e. setting of route, clearing of signal etc.

- E-TSR is being managed by Local ASM.

- Talking to ASM frequently and train data entry by CTC operator reduced. Moreover as signal operation is being done in front of him, he can manage it well and efficiently.

2.3 Operational features

- **Block System**: Kanpur-Ghaziabad section is fully automatic including yards. Trains are visible at entire length of section.

- **Gate Working**: All gates in CTC territory are interlocked and approach warning from 4 Km is given to Gateman for closing of Gates.

- When the Gate is closed Gateman presses the button after verification of tracks the Gate gets locked and the Gate Signal get approach cleared from 4 Kms. ASM need not exchange
private no. with Gateman for closing of gate. (This aspect will be important in Commissioning of CTC in Non Automatic Territory)

- Signals are cleared by CTC operator and planning done by Section Controller. Train charting is being done by local ASM via E-TSR.

### 2.4 Operational benefits

- Centralized Operation of Signaling Systems for a large section encompassing multiple interlocked stations and Real time Monitoring of Train Traffic for enabling efficient decision making
- Operator can set the long routes within a territory with a single command. CTC operator of particular territory can operate all the signals, points, routes of any station of his territory from CTC in Aligarh-Kanpur section. (Presently 30 stations in 270 Route Kilometers are managed from CTC)
- Train ID (Train Number) can be entered either by CTC or by Local ASM.
- During operation from CTC, all the operations being done will be visible to local ASM on his panel along with indications of status of availability of CTC or Not CTC.
- The response time between a change of state at a way side station and its display at CTC is less than 2 Seconds.
- ASM at station and CTC operator can handover/takeover control in mutual cooperation or in emergency directly with a set of commands in drop down menu.
- Time Table Management will allow Input a Time Table, Input additional trains, Change Time Table data temporarily or permanently.
- Time deviations shall be displayed in different Color i.e different color for Deviation Ahead, No Deviation, Deviation behind Time Table.
- Train Describer System (Train ID) Management.
- Automatic generation of Train Graphs to facilitate finding gaps in the path and plan movement of unscheduled trains.
- Time Line Charts shall be storable and printable for every time period and at any time for later evaluation.
- Conflict solving for the execution of planned train connections, crossing moves and passing moves.
- Line Overview, Zoom View, Time Line Chart shall be available.
- Other controllers can see status of section without disturbing the section controller (Wall display).
- Most of the features of LCP shall be available in CTC for e.g. Emergency Release etc.

**Figure 10: CTC System Architecture**

### 2.5 Maintenance Benefits
- Playback for a large section is possible.
- Alarm Management
- Monitor network device status of complete section from central location.
- Data Logger System with Real time Messages for Failures.
2.6 Wall display
Wall display layouts designed to show sequential train operation from Panki to Chipyana Buzurg stations, both UP and DN lines. For big yards only Main line and Running loop lines are shown on wall display. (Complete Yard is displayed on Workstations)
2.7 **Train ID Colour and Train graph Colour**

- Train ID and train graph will use the same colour to represent the type of train which are being currently used by Indian Railways

**Currently used colours in Tundla control**

- Red- Mails, Express and other trains requiring top priority
- Blue- Passengers
- Green- Military specials, Crack Special, Fast Express Goods and any other important Good Trains.
- Pink- Rajdhani, Shatabadi, Duranto.

**Train ID diagrams**

**Figure 13 : Train ID Block**

```
+-----------------+              +-----------------+
| Direction and   |              | Direction and   |
| On-Time Status  |              | On-Time Status  |
| Arrow           |              | Arrow           |
+-----------------+              +-----------------+
|                 | Train ID Block|                 |
|                 | Max 8 Characters|                 |
+-----------------+              +-----------------+
```

**Figure 14 : Time Status Arrow**

```
+-----------------+              +-----------------+
| Scheduled Train |- On Schedule | OR               |
| Scheduled Train |- Minor Delay  | OR               |
| Scheduled Train |- Major Delay  | OR               |
|                  | Unscheduled Train| OR               |
+-----------------+              +-----------------+
```
2.8 Communication arrangement between Controller and Station Master/Level Crossing (Both fixed and Mobile)
Fixed Line Communication at stations through ISDN phones are connected with Child Exchanges at each Station. At Gates ISDN phones are connected with Child Exchanges of Stations and at far locations they are connected through LAN Extender.
All Child Exchanges at Stations are connected through OFC from Tundla Mother Exchange.
For communication between either CTC Controller or Station Master or Gateman, ISDN phones are provided with One press Button facility. Mobile Communication is through GSM-R.

2.9 Working of LC Gates under CTC operation
- All gates in CTC territory are interlocked and approach warning from 4 Km is given to Gateman for closing of Gates.
- When the Gate is closed Gateman presses the button after verification of tracks the Gate gets locked and the Gate Signal get approach cleared from 4 Kms.
- This feature of Approach Warning and Approach Clearing is currently in vogue in the Automatic territory and therefore the SM need not communicate with Gateman during Normal Working.
- However in case of exigencies the SM, CTC Controller or Gateman can always communicate with each other by just pressing a single button on the ISDN phone provided.

*Figure 15: Communication from Controller to SM/LC Gate (Both fixed & Mobile)*
2.10 **Shunting operations under CTC Territory**

- Shunting under CTC operation will be carried out by the Local SM as per GR Para 5.15(2).
- When Shunting is required to be carried at a Station the operational control of Microlok EI will be transferred to Local SM from CTC Controller through mutual cooperation of both.
- All main line movements in such case along with shunting operation will be carried out by Local SM on the instructions of CTC Controller.

2.11 **CTC System Infrastructure**

The complete CTC infrastructure consists of following assets:

(a) **Traffic Management Subsystem (TMS)**

- 2 Database Servers
- 2 Communication Servers
- Storage Cluster
- Commissioning Database Server
- 6 Section Controllers workstations
- 1 Chief Controller workstations
- Wall-display (composed of 24 monitors and managed by 3 workstations)

*Figure 16: CTC Equipment Room*
(b) Service & Diagnostic Subsystem (S&D)
   - S&D server
   - Maintenance workstation
   - RCE (recording of chronological events) workstation

(c) Wayside Equipment
   - Local Control Panel (LCP) at stations
   - MLK Peripheral Post (MPP) to interface with EI, LCP and CTC

(d) Data Transmission Network

(e) Network Equipments: CISCO Router and switches, RuggedCom WAN media converters

(f) Double ring OFC: Two OFC Rings with 24 Core Optic fibre as main link and protection ring is provisioned over Railtel optical fibre.

(g) Network Time Synchronization by GPS clock.

(h) Network Security System: 2 Firewalls and 2 Firewalls analyzers

*Figure 17: CTC Wayside Station Architecture*
(i) **UPS:** 40 KVA UPS  
(j) **DG Set:** 320 KVA  
(k) **Building:** Control Centre and Portacabin  
(l) **Air-Conditioning System:** for Control Centre and CTC Equipment Rooms

### 2.12 Experience gained from CTC Tundla

- Good and spacious building for CTC is required to cover length of the section, no. of stations, clear viewing distance and Resolution in display. The viewing distance calculated is 7.5 Mtr and the size of the Font calculated is 33 mm
- No any FRS/SRS and RDSO specifications were available. Proceeded with Tender Conditions and schedule.
- With CTC Additional hardware is added. Staff was trained at site.
- For deciding whose sanction is required for CTC commissioning, CRS/NE-C advised to go for PCSTE sanction.
- Special Instructions required to implement CTC as per GR 9.09. In NCR Issued on 01.03.2018.
- CTC commissioning depends on Automatic works and EI commissioning at site. New CTC sites should work on both simultaneously.
- The automatic commissioning should be done as per RDSO recommendation. (OFC based auto-signalling).
- Ring protection via OFC is must. OFC network is like veins of CTC. OFC Cuts and losses result in failure of CTC network as all station are connected.
- Finalization of draft of Temporary Working Rules for guidance of ASM and CTC operators took more than two and half years.
- Training of CTC operators and ASM at wayside stations was required to be done.
- From the experience, the need was felt that for Normal Takeover and Emergency Takeover, there should be an auto command in case of failure of communication between CTC and ASM, and if ASM can’t take over, command then can be automatically transferred to local ASM in 3-4 min.
2.13 Post Commissioning challenges

- Many stations VDU view was disturbed for 5-10 min. even when there was single fiber cut, as all stations connected serially via IP Networking. (Rectification: By improving the OFC losses and connectivity at every station).
- Train ID missing cases on Workstations. (Rectification: CTC Software modification done).
- Irregularity in Route stacking command in main line. (Rectification: CTC Operators were suitably counselled).
- Route setting over a flashing Point (Rectification: Software customized as per local requirement as earlier it was based on European standards).
- Cases of False Indications. (Rectification: Regular staff Counselling regarding incomplete operations by two step command and also by popping up a notification alarm).
- Frequent changes in any section/station/LX gates in CTC territory of 397 Route Kilometer has to be incorporated in the CTC software immediately to prevent blackout of that particular section. Needs continuous monitoring and feedback from all the units working in the section.
- TMS (Train Management System) not used by Section Controller due to different concept than COA. Difficult for Controllers to work in two different systems ie CTC and COA.
- Integration of CTC data with COA can solve above issues as applications like NTES, COIS, FOIS fetches data from COA and not CTC train graph.
- Although control is at CTC but decision improving systems are required like MIS, Automatic Train Supervision, intelligent applications guiding controller e.g. any slow running High Speed Train should create an alarm to controller.

2.14 Recommendations to overcome drawbacks

From the experience gained after commissioning of CTC Tundla, following are needed to be incorporated to overcome the challenges faced:

- Integration of COA, NTES, FOIS, COIS, SCADA etc. with CTC.
- Interfacing & real time data sharing with COA, Crew management system, PA system at station, ETCS L-2/TCAS etc.
- This system should have facility of Automatic route setting (ARS), Long route setting, Route stacking command for avoiding repetitive operation by controller.
Reorientation and reconfiguration of wall display. Legibility limits must be considered to develop adequately the orientation of stations on the wall-display and the dynamic allocation of territories.

**Option 1**

![Diagram of Option 1]

Figure 18: Orientation of stations in the wall-display and dynamic allocation of territories – Option I

**Option 2**

![Diagram of Option 2]

Figure 19: Orientation of stations in the wall-display and dynamic allocation of territories – Option II

- Alignment of CTC terminals with COA boundaries.
- Larger font size required for better visibility.
- Built in intelligence recommended which can plan judicious precedences.
- Way to reduce strain on eyes using Anti-Glare screen.
- Amendments in G&SR, JPOs, special instructions etc. for CTC working.
- Quick changes as per changes in layout.
- Inclusion of TWRD, station kilometers, platform nos. and CSRs which helps better planning and imposition of Power and Traffic Block.
- Responsibility of Train Stopping-Driver; Train Starting-Guard with through Signals.
- Provision of separate color for the ID of High Speed Trains and priority trains is essential for better observation.
- An efficient Passenger Information System and Public Addressing system.
- Interlocking interface shall be based on open, non-proprietary standards. All details of interlocking interfaces including data structure, CRC, Checksum details, communication process & protocol shall be shared by the TMS vendor. TMS product shall develop necessary protocol converter for interfacing with different interlocking system. Protocol of interlocking system shall be made available by Railway in liaison with interlocking vendors. EI OEM to provide the Protocol Converter PC with Standard Protocol defined by RDSO for any CTC project.
- FRS (Functional Requirement Specification) and SRS (System Requirement Specification) should be mutually agreed to and approved in time bound manners. (S&T and Traffic Dept.).
- Safety Standards should be clearly mentioned (included in RDSO Draft Specifications)
- Issuing of Special Instructions (and subsequently Temporary Working Rule by Sr DOM) for CTC as per GR Para 9.09 (Working of Trains on Centralized Traffic Control Territory – On a section where CTC is in operation, the working of trains shall be governed by Special Instructions).
- Working of Gate Closing/Opening in Non Automatic Territory.
- Block Working from CTC in Non Automatic Territory. Working of CTC in Dhamra Port is an excellent example.
- CTC should be made interactive, i.e. Controller should be able to generate traffic related queries from the system (Like expected bunch of trains in DN/UP direction for planning loop line movements).
- The system shall be able to generate various MIS report, train graph and detect and manage alarms and logs generated in the system.
- Voice Recording system in CTC for quality analysis and in emergency. (Like Voice Loggers in present controls)
- Proper building preferably at central location of the project. Additional adequate space should be available for any future expansion.
- Power Supply: Minimum three power supply back up system should be available. Main Source should be AT Supply.
- Air conditioning, Fire Alarms management, lighting, acoustics, emergency exits, access control are some of the features to be taken into consideration. Please refer to the draft Building Specifications for CTC.
- For relay interlocking if it is old installation that shall be replaced with new EI system before implementing CTC.
- In case of CTC to be embedded on relay interlocking system, IR should ensure hassle free connectivity between relay contact and CTC field interface unit.
- During CTC/Local operation of RRI/PI station, conventional block instrument needs to be replaced with SSBPAC/UFSBI.
- Since response time is a critical factor during CTC operation, Hence communication networking upgradation is a mandatory requirement.
References

1. RDSO Draft Specification No. RDSO/SPN/212/2012 Version 0.2 (Draft) for Train Management System/Centralized Traffic Control (TMS/CTC).
3. Presentation slides on “India's first Centralized Traffic Control (CTC) System with Electronic Interlocking for Bhadrak- Dhamra Port (ECoR).” (Dt. 30.07.2020) by Shri A K Chopra, IRSSE (Retd.) Former MD RailTel/ Retd. GM IR.
4. Presentation slides on Centralized Traffic Control at Tundla for CNB-GZB section of NC Railway, 11.10.17
5. Presentation slides on “CTC Tundla Experience & Lessons learnt” by Shri Vijay Malviya, Professor (S&T) National Academy for Indian Railways (NAIR), Vodadara
6. Presentation slides on “Performance of CTC, Tundla & Action Plan for setting up of CTCs on IR.
“We at RDSO Lucknow are committed to maintain and update transparent standards of services to develop safe, modern and cost effective railway technology complying with statutory and regulatory requirements, through excellence in research, designs and standards by setting quality objectives, commitment to satisfy applicable requirements and continual improvements of the quality management system to cater to growing needs, demand and expectations of passenger and freight traffic on the railways through periodic review of quality management systems to achieve continual improvement and customer appreciation. It is communicated and applied within the organization and making it available to all the relevant interested parties.”
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