

RADIO BASED ETCS/PTC IS THE MILLENIUM TOUCHSTONE FOR CAPACITY, SAFETY & EFFICIENCY IMPROVEMENT ON PROGRESSIVE RAILWAYS

Chandrika Prasad
Principal Consultant (Signal & Telecom)
Delhi Metro Rail Corporation

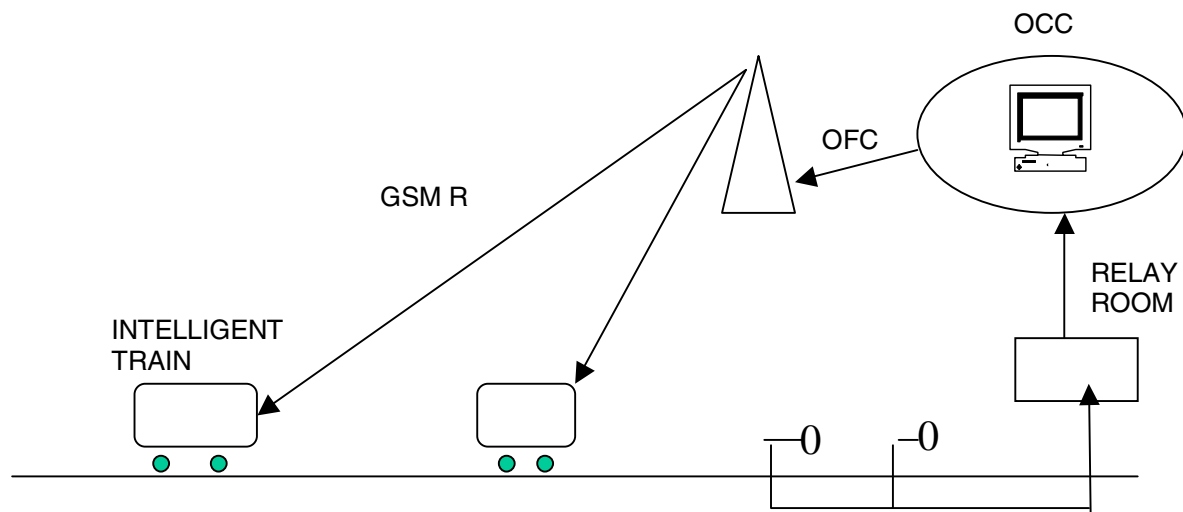
Signaling of 21st century will no longer be concerned simply to signal the driver and provide safety net to prevent accidents due to human error, but will play a major role in the management of railway operation to maximize the use of scarce resources and optimize the investment in infrastructure. The recent development in radio based signaling i.e. ETCS in Europe and PTC / ITC in USA are a major break through in providing signaling solutions for improving railways' performance. While in Europe radio based ETCS is being primarily adopted to meet interoperability, safety and high speed train control requirements for Progressive Railways; this new signaling technology provides single window solution to improve capacity, safety, operational/maintenance efficiency and to provide real-time train information and to generate tele-revenue on their network. As an example, the author has described the existing signaling and telecom scenario on Indian Railways and the improvements which will accrue with introduction of radio based ETCS system. To meet the challenges facing progressive railways in the new millennium, the author suggests adoption of long term strategy for modular introduction of radio based ETCS/ PTC signaling on the select routes and gain the progressive increase in capacity, safety, operational & maintenance efficiency and tele-revenue on their network.

INTRODUCTION

Since the time railways started in 19th century, new concepts are being adopted to signal the driver to control his train. In the beginning of the railways, trains were signaled by the arm of the traffic policemen, posted along the track. By mid ninetieth century the arm of traffic policeman took the form of Semaphore Signal – whose mechanism were ingeniously developed and adopted world over. The beginning of twentieth century saw the advent of color light signaling. The first illuminated diagram in the world was installed in 1905 at Mill Hill on the Metropolitan District Railway in the UK along with color light automatic signaling. The 20th century can be said to be the era of color light signaling. It dominated the railways signaling scenario worldwide. It was towards the end of 20th century, with rapid development in communication based signaling that a new concept of signaling the driver in cab started taking shape. The major break through in radio based ETCS / ITC signaling in recent years provide an unique technology to achieve this vision. While in Europe, ETCS is being provided to meet interoperability, safety and high speed train control requirements, for Progressive Railways it provides a single window solution to the multiple requirements to improve capacity, safety, operational / maintenance efficiency, tele-revenue and to provide real – time train information to public.

WHAT IS RADIO BASED ETCS/PTC ?

In radio based ETCS / PTC system , signaling based commands and all information concerning train movement ie. Distance to go, LOMA , target speed, maximum speed ,temporary / permanent speed restriction etc are transmitted in fail -safe way to the cab via radio and displayed on the driver's MMI. In case the driver , misses to control his train as per these signals , the ETCS / PTC system automatically brings the train within the safe speed envelope or to a halt depending upon the situation. The signaling status available in the cab can be used to provide train approach warning at level crossings or to staff working at site and various value added services for passengers etc. The schematic plan of radio based ETCS / PTC is shown below :



RADIO BASED ETCS / PTC SYSTEM – DEVELOPMENT WORLDWIDE

During the ERTMS World conference of UIC held at Florence in 2000, the new technology of ETCS was considered proven and overwhelming feeling of suppliers and railways alike was that the moment has arrived to transform this new technology into commercial entity . After more than one decade of the European Union (EU) launching the ETCS project , a major mile stone in the history of Railway Signaling was reached in Bulgaria in October 2001 with completion of ETCS level 1 project on 250 kms section on Sofia – Burgas line . This was followed by Swiss Federal Railways (SBB) commissioning in April 2002 , ETCS level 2 in commercial service on its 35 kms line between Sempach and Zofingen . A total of 59 locomotives have been fitted with in - cab equipment and they will operate upto 140 kmph on the mixed traffic route . SBB hopes eventually to operate passenger services using ETCS at two minutes headway .It also plans to extend ETCS throughout its entire network during next 10-20 yrs .There are currently 25 ETCS projects in various stages of progress in Europe .

In USA , AMTRAK has activated radio base ITC signaling on Chicago- Detroit section and the PTC project is in progress on Chicago - St Luis section.

The table below shows the progress of ETCS / PTC signaling on world railways :

Country Implementation	Test Section	Commercial
Switzerland	Oltten- Lucerne ETCS level 2 test completed	ETCS level 2 in commercial Operation on Sempach- Zofingen line Entire SBB with ETCS 10-20 yrs
Bulgeria	Sofia – Burgas Test completed	ETCS level 1 in commercial operation
Italy	Florence – Arrezo- Rigutino ETCS level -1,2,3 test upto 300kmph started Oct 2000	Rome – Naples H S line ETCS level 2 by 2004
Germany	Ludwigsfelde-Juterborg ETCS Level 1,2,3 test upto 200 kmph started March 2001	Berlin- Halle/Leipzig ETCS level 2 by mid 2003
Spain	La Sagra – Mora , Functional & Interoperability tests of Eurobalise, Euroradio, Eurocab, elements completed in 2000	Zaragoza- Lerinda H S line ETCS level 2 by mid 2003
Netherlands	Heerlen- Maastricht ETCS level 1,2 ,3 test started in Mar 2001 & on Meppel-Leeuwarden	Amsterdam-Utrecht Amsterdam- Belgium border Amsterdam- German border ETCS level 2 by 2006
Britain	Old Dalby test track ETCS level 1,2 upto 200kmph test started Mar 2002	West Coast main line by mid 2005
France	Junction TGV ETCS level 2,3 test upto 270 kmph started	Nimes- Montpellier TGV Est ETCS level 2 by 2006
USA	Chicago- Detroit radio based ITC system test completed	Chicago –Detroit radio based ITC system activated by AMTRAK early 2001 Chicago – St Luis PTC System Contract awarded
India	Mathura -Palwal Pilot Project	

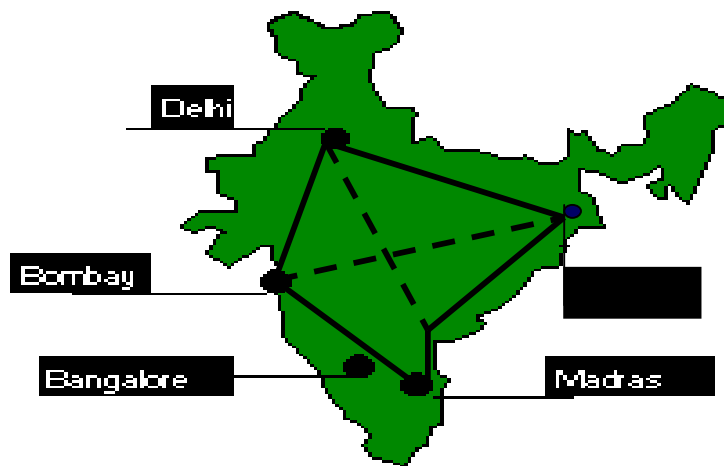
ETCS level 2
Tender to be floated .

So the technology of radio based ETCS / ITC is a reality . It has been tested, validated and is now in commercial service .Now let us see what application it holds on Progressive Railways ?

The extent of improvement which radio based ETCS / PTC signaling will bring on a railway will depend upon the existing infrastructure scenario on that railway and the up gradation which the introduction of radio based ETCS / PTC signaling will bring on its network. For example let us look into the existing scenario on Indian Railways and what application radio based ETCS level 2 / PTC holds on its network.

EXISTING SCENARIO ON INDIAN RAILWAYS

The historic journey in 1853 between Bori Bunder and Thane heralded the beginning of railways in India . Today Indian Railways have a multiple gauge network of 63000 route kms . Out of which 22% is electrified . There are 7000 stations and a fleet of 7400 locomotives ,32000 passenger coaches and 244000 freight cars / wagons . Indian Railways carry 450 million tons of freight traffic and 5000million passengers every year .



On Indian Railways broad gauge network over 60 % of the traffic is concentrated on Golden Quadrilateral and the diagonals formed by 4 metropolitan cities of Delhi, Kolkata , Mumbai and Chennai. Future growth of traffic on these routes is also anticipated to be to be much higher than the rest of the network . In a recent seminar held at railway staff college on India Railways Vision 2025 it was assessed that by 2025 the freight traffic is expected to reach 1107 million tons and passenger traffic will increase by 300 %.

The question is will this traffic be moved by adding new lines / infrastructure or by optimization of the existing infrastructure ?

Color Light Signaling was started on Indian Railways in 1920s . By now over 60 % of the stations are equipped with MACL Signaling . The balance stations have

Semaphore MAUQ , MLQ & LQ Signaling .There are 5649 interlocked stations . Out of which 13 are equipped with Electronic Interlocking , 2100 with Relay Interlocking ,and 3549 stations have mechanical lever frames

There is no Centralized Traffic Control System on Indian Railways . Train movements are telephonically monitored & controlled from 79 control centers located 100-300 kms apart. Movement directions are given by controller to station masters over control telephone circuits and train movement chart is mostly manually plotted .

Now let us look at Infrastructure optimization on Indian Railways and the rail world .

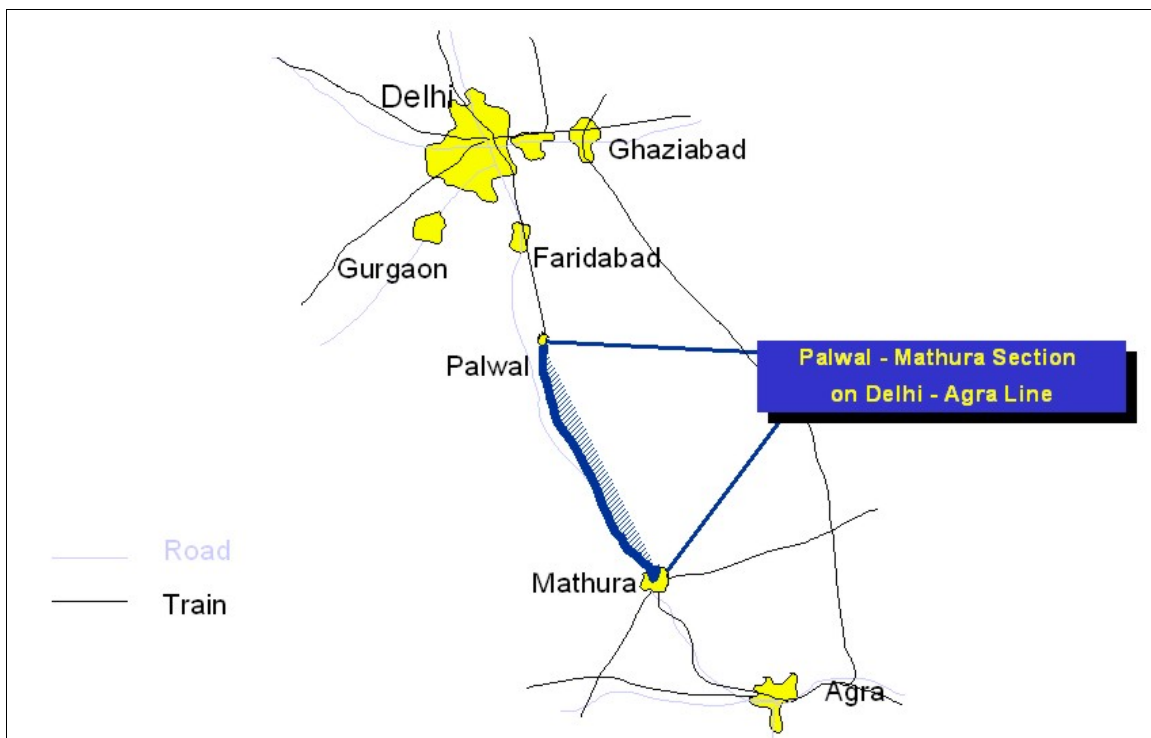
RAIL INFRASTRUCTURE SCENARIO

Items	Indian Railways	Rail World
i) D / L Capacity	65 trains / way	over 120 trains / way SBB Plans 2' headway with ETCS
ii) Speed	130 kmph Maxm. (against design speed of 160 kmph on A route)	Over 300 kmph
iii) Automatic Signaling	2.7 % of the route	90 % of route UK 67 % of route Japan 84 % of route China
iv) Operation Control Center	Train monitoring by phone & Manual charting	Computer based on-line Train Monitoring & Remote control
v) AWS / ATP	NIL on main routes	Commonly provided on main routes ATP compulsory on JNR* *Our trains do not collide we have system to prevent that. *99.9999% safety not acceptable"
vi) Mobile Train Radio	2 % of main routes	Commonly provided on Main routes
vii) Maintenance Support	Manual check & reporting	On line monitoring & Diagnostic support
viii) Train	Manual input of train Information to A/V & IT based passenger Information systems	Real time train information on A / V and IT based Pass. Inform. system
ix) SAFETY	66% Of Accidents on I R are due to Human Failure	Where Human Err s TECHNOLOGY is the Answer

From the status presented above it is evident that application of modern technologies is the key for optimization of infrastructure on Indian Railways .

In recent years several steps towards induction of new technologies have been taken on Indian Railways . In the field of signaling and communication new technologies of Electronic Interlocking , AFTC , Digital Axle Counters , Failsafe Multiplexure , LED Signals and ,OFC have been introduced . Aged Signaling at 881 stations are being replaced . A remote control and train describer system is under commissioning in Mumbai suburban area . Newly created Railtel Corporation has taken up an ambitious project of laying of OFC on 35000 kms of Indian Railways . GSM-R radio communication between driver and control has been sanctioned on 2500 kms of Indian Railways .

To experience the application and technical validation under Indian conditions , a pilot project of ETCS level 2 on Mathura - Palwal section has been sanctioned . The tender for the same is to be floated .



APPLICATION OF RADIO BASED ETCS / PTC ON INDIAN RAILWAYS

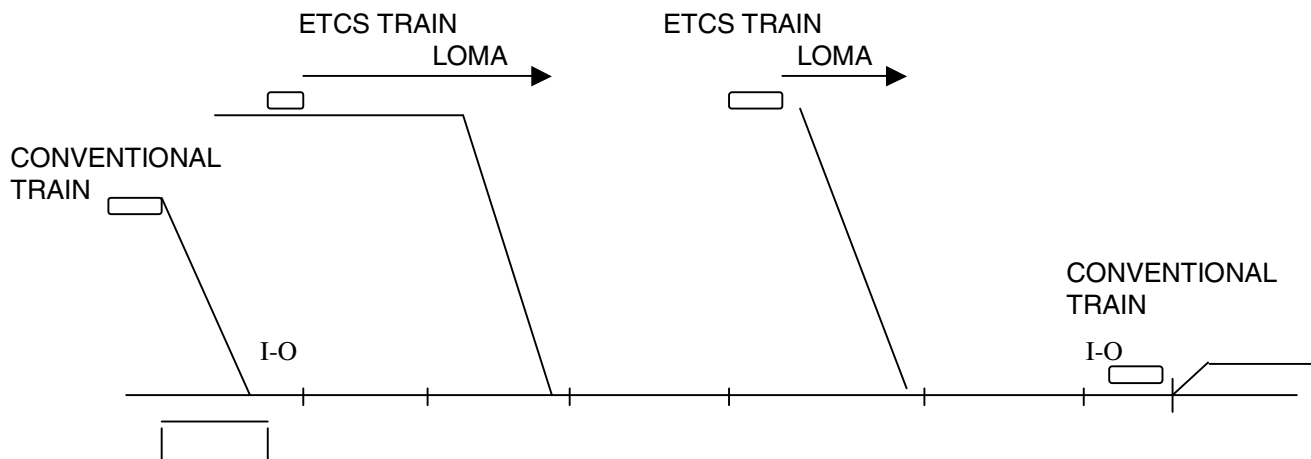
Under the existing signaling and telecommunication infrastructure explained above, the application of radio based ETCS / PTC will make a major breakthrough in the following areas:

- “ LINE CAPACITY “ INCREASE
- “ MULTI FOLD SAFETY IMPROVEMENT”
- “ OPERATIONAL EFFICIENCY IMPROVEMENT ”
- “ MAINTENANCE EFFICIENCY IMPROVEMENT
- “ REAL-TIME TRAIN INFORMATION TO PUBLIC ”
- “ COMMERCIAL USE OF COMMUNICATION BACK UP

Line Capacity Increase

Under radio based ETCS system, the train movement authority ie. the maximum permitted speed, the target speed , the actual speed ,Distance to go and other related information is transmitted to locomotive and displayed in the driver's Cab. The ETCS equipped train has full back up of automatic train protection ,in case of human failure of the driver . Thus ETCS enables not only running of the train at maximum permissible track speed but also at the maximum speed up to the point of application of service / emergency brake of the train .In addition , ETCS takes into account the actual braking characteristic of the train rather than following the worst braking convention. As a result ETCS equipped train run more closely to a train ahead rather than that of the conventional system.

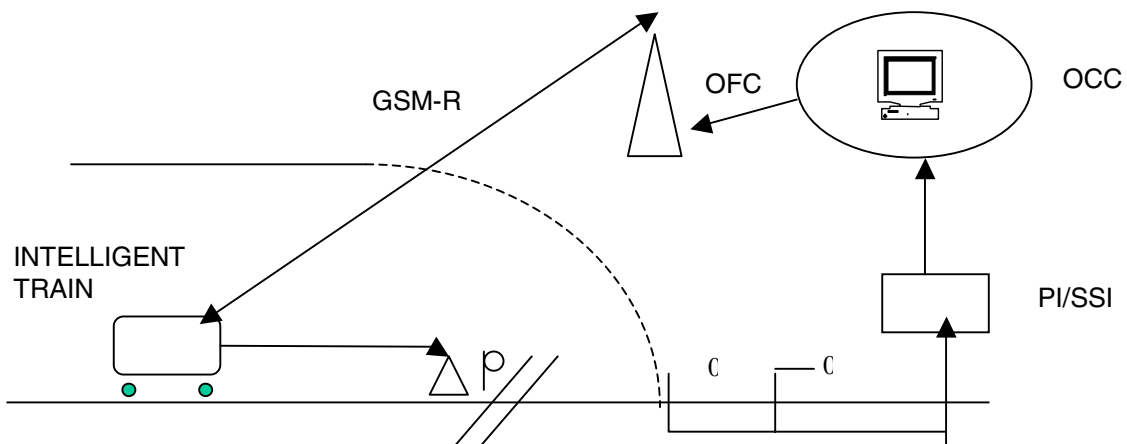
In absence of any ATP system on Mathura _ Palwal section of Indian Railways ,the maximum permissible speed has been reduced to 130 kmph , whereas track design is for 160 kmph . With proposed introduction of ETCS level 2 on this section , it will be possible to optimize the track speed potential of the section and ETCS equipped train can run up to the maximum speed of 160 kmph. This will be a major step towards increasing the throughput on the section .



Further improvement in the sectional capacity can be achieved by providing track sections and interfacing it with the signaling system. While non ETCS equipped train can run on conventional signaling aspects, for ETCS equipped train ,a 'Blue ' signal will be lit, to indicate to the driver that he is running in ETCS mode with full ATP protection .Thus ETCS equipped train - following LOMA principle will run closer to the train ahead with full safety , thus offering an unique opportunity to bring over increase in line capacity , meeting the requirement of additional capacity on the section for years to come .

Multifold "Safety Improvement"

With the back ground of existing signaling & telecommunication infrastructure on Mathura – Palwal section of Indian Railways, the introduction of radio based ETCS level 2 on this pilot section will provide multifold improvement in the safety in the areas as given below :



- (i) Prevention of accidents due to driver passing ' Signal at Danger ' (SPAD)
- (ii) Prevention of collisions by automatic braking / speed control
- (iii) Prevention of accidents at Level Crossings by automatic approach warning
- (iv) Prevention of unusual incidences using reliable GSM-R mobile radio communication between driver and control / station
- (v) Prevention of accidents at work site by automatic approach warning to staff

Unlike piece meal improvement in safety brought by individual signaling and communication sub systems in the past , radio based ETCS level 2 brings a consolidated, state of art technology solution for several urgent safety improvement needs of Indian Railways. So, for Indian Railways radio based ETCS / PTC opens a new vista of opportunities for multifold improvement in safety and substantial reduction in accidents on its network.

Mobile Train Radio Communication

The transmission backbone of ETCS is GSM-R radio and OFC network . GSM-R is a future oriented digital radio communication system , which not only provides mobile radio communication between driver and control but has been designed for additional application of

- Shunting Radio communication
- Group Communication
- Addressing Functions
- Diagnostics & Maintenance Communication
- Ticketing & Schedule Changes Communication
- Value Added Services for Passengers

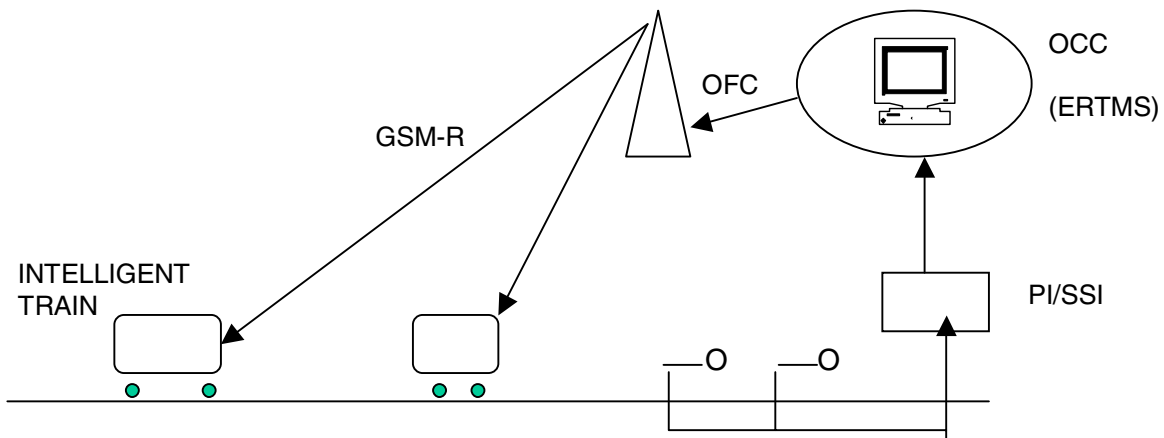
At present over more than 80000 kms of section on different Railways in the world, GSM-R radio are either being planned / installed or used .

Eight spot frequencies in 900 Mhz GSM-R band has been allotted by Wireless Planing Authority to Indian Railways

Adoption of GSM-R on Indian Railways offers an unique opportunity to have a commercially available mobile digital radio system ,which will not only enhance safety by providing emergency radio communication between driver and control ,but will also improve operation and maintenance efficiency.

Operational Efficiency Improvement

With commissioning of radio based ETCS on Mathura – Palwal pilot section , the exact location and running of all trains in the section will be displayed on VDU monitors of the controller at Agra Control Center .It will make available to the controller the actual train characteristic & running performance of ETCS equipped trains, rather than the assumed performance as used in the conventional method. Thus ETCS provides actual running and reliable projection of train performance to the controller to plan & control the train operation, overtaking/ crossing in his section and to upgrade the plan well in advance. This will be a major step in upgrading train management control on Indian Railways from the present scenario and will greatly improve operational efficiency of Indian Railways .



Maintenance Efficiency Improvement

The ETCS system continuously monitors the on-line status of signaling and telecom systems on the section. This data can be gainfully utilized for Predictive Maintenance (instead of conventional maintenance) of signaling & communication, track systems. Similarly the on- line status of loco equipment can be transmitted on GSM-R network to control center to aid diagnostic and preventive maintenance for loco. Thus ETCS provides unique opportunity for improving the maintenance of signaling , telecom systems, track and locomotives on the railways . It opens an avenue to switch over from time schedule maintenance to need based maintenance bringing substantial saving in maintenance cost .

Real-time Train Information to Public

The train running information made available by ETCS system in the control center , can be interfaced with audio /visual train running information devices provided at stations , centralized / station enquiry offices and internet based services - thus commencing a new era of providing real -time train running information to public.

Commercial use of Communication Backup.

The telecom infrastructure of OFC , GSM R radio , radio towers , OFC/ GSMR equipment rooms along the track can be leased / shared with telecom operators to generate additional revenue .

CONCLUSION

The introduction of radio based ETCS / PTC signaling will provide over 100 % increase in capacity , with enhanced safety , better operational & maintenance efficiency , additional tele revenue and real time train running information to public. This new signaling thus provides single window solution for improving capacity, safety & efficiency on main routes of Indian Railways

To meet the challenges facing Indian Railways in the 21st Century an Integrated action plan for introduction of SSI, OFC , GSM –R sub systems and progressive introduction of ETCS/ PTC Signaling on the main routes , provides the optimal solution .

LOOKING AHEAD

- 1.) Signaling of 21st Century will no longer be concerned simply to signal the train driver and provide safety net to prevent accidents due to human error but it will play a major role to enable that the railway operates efficiently and maximizes the use of its scarce resources & optimizes the investment in its infrastructure.
- 2.) The recent development in radio based signaling of ETCS in Europe and PTC / ITC in USA is a major break through in providing Signaling solutions to the multiple needs of improving Safety, Capacity ,Operational / Maintenance Efficiency and to provide real time train information on Progressive Railways

- 3.) A wind of change is blowing over the rail world . As the years of the 21st Century roll over, a sea change will happen on the main routes of Progressive Railways.
- Line side Signals will go into oblivion yielding to in- cab signaling .
 - OCC will have computer based on-line monitoring & remote control .
 - Intelligent trains will haul freight & passenger services .
 - The present profile of “Signaling for Safety” will change to “Signaling for Capacity , Safety and Efficiency”

About the Author

Mr. Chandrika Prasad has been head of Indian Railways Signaling for 5 years (1996-2001), during which he was responsible for introduction of several new signaling technologies to improve safety and system availability on Indian Railways. He successfully led the team for design & installation of remote control & train describer system at Delhi. On deputation abroad, he worked as Senior Expert for planning & designing of Signaling & Telecom systems for high speed rail network in Iraq. While working on Indian Railways he was instrumental in conceptualization and sanction of ETCS level 2 pilot project on Mathura – Palwal section. Subsequently he also served as a Member of ETCS Task Force of International Union of Railways. Mr. Prasad is based at Delhi and is presently serving as Principal Consultant to Delhi Metro Rail Corporation. He has over 20 papers published in national & international journals to his credit.

Address :
CHANDRIKA PRASAD
Principal Consultant (S&T)
Delhi Metro Rail Corporation
Plot B 71, Sector 51
NOIDA (UP)
INDIA 201307

E mail : chandrika_prasad@yahoo.com

Phone +91 120 4481634
Mobile +91 9810343931