विद्यया विन्दतेऽमृतम्

The Institution of Railway Signal & Telecommunication Engineers

Journal
October - December, 2007

OFFICE BEARERS OF
THE INSTITUTION OF RLY. SIGNALLING & TELECOM
IRSTE (INDIA)
HEAD QUARTERS

PATRON	**:**	Shri S. K. Vij, Member Engg as Member Electrical, Railway Board
President	**:**	Shri Mahabir Prasad, AM / Sig, Railway Board
Hony. Vice President	**:**	Shri A. K. Kapoor, AM / Tele, Railway Board
Hony. Vice President	**:**	Shri S. K. Vashishtha, MD, RailTel
Hony. Secretary	**:**	Shri Kundan Chaudhary, CCE, Northern Railway
Hony. Treasurer	**:**	Shri Anshul Gupta, GM / Marketing, RailTel
Hony. Joint Secretary	**:**	Shri Gautam Arora, Director (QA) / S&T / RDSO, New Delhi

ALLAHABAD CHAPTER :
President : Shri P. K. Srivastava, CSTE/NCR
President : Shri M. Suresh, CSTE/CORE/ALD

BHUWANESHWAR CHAPTER :
President : Shri M. C. Sethi, CSTE/ECOR

BILASPUR CHAPTER :
President : Shri Mahboob Ali, CSTE/SECR

CALCUTTA CHAPTER :
President : Shri G. G. Biswas, CSTE/ER
President : Shri S. Murlidharan, CSTE/SER

CHENNAI CHAPTER :
President : Shri B. Krishnakumar, CSTE/SR

DELHI CHAPTER :
President : Shri G. D. Bhatia, CSTE/NR

GORAKHPUR CHAPTER :
President : Shri Prahlad Swarup, CSTE/NER

HAJIPUR CHAPTER :
President : Shri A. K. Mishra, CSTE/ECR

HUBLI CHAPTER :
President : Shri S. Manohar, CSTE/SWR

JABALPUR CHAPTER :
President : Shri K. S. Krishna Kumar, CSTE/WCR

JAIPUR CHAPTER :
President : Shri Ravender Singh, CSTE/NWR

LUCKNOW CHAPTER :
President : Shri C. P. Verma, Sr. ED/Signal/RDSO

MUMBAI CHAPTER :
President : Shri K. D. Sharma, CSTE/WR
President : Shri R. C. Agarwal, CSTE/CR

SECUNDERABAD CHAPTER :
President : Shri Ananda Kumar, CSTE/SCR

CONTENTS

GENERAL SECRETARY'S LETTER

Dear Members,

The aim of the Institute is to disseminate and share technical knowledge relating to design, construction, maintenance and adoption of modern S & T systems amongst persons associated with it. To this end the technical journal plays a vital role facilitating interchange and sharing of ideas.

Some efforts have been made by CSTEs to increase membership of the Institution, however it needs to be enhanced this has been committed in the last CSTE's conference held at New Delhi also. Life membership fee of our institution is the lowest among other similar comparable organizations. Each Life Member should make endeavor to make at least four new members in a year by spreading the message. In fact many individual and organization are interested but all of us had to tell them and pursue.I hope Heads of the Department and officers of S & T Organisaiton should encourage and persuade their officers and fellow S & T colleagues to take the benefit.

Recently, our own PSU, RailTel celebrated its 7^{th} Annual Day. It was a success and shows as how S&T engineers can do wonders in short period of time.

As informed, we are planning to hold 3^{rd} International Signalling and Telecommunication Equipment Exhibition cum Seminar in February, 2008 to be attended by representatives of World Railways, Industry and Technical Experts. It should be our endeavor to make it a grand success by way of active participation and contribution. Your suggestions in this regard are very valuable

Distribution of this issue of the journal is directly done through CSTE's or Sr. DSTE's in the Railways as postal address in many cases gets out dated and not really available with IRSTE. It would be appreciated if members send their correct mailing address to undersigned to Shri Anshul Gupta. Of course, our esteemed retired members and sustaining members do get their copies by post. It is of course, essential that the retiring members do furnish their mailing address in advance to ensure prompt delivery and continued service.

Hope that you will find this issue an interesting one.

Sincerely yours

(Kundan Chaudhary)
General Secretary, IRSTE

New Delhi
October, 2007

APPEAL FROM EDITORIAL BOARD

This issue brings out articles on the Evolution Telecom system in the world. Issue also summarise state of art modern technologies in the field of Signalling & Telecom.

Editorial board, requests you all to complete list of members on your railway and send the same to this office. Secondly, they should bring out good articles then it is pointed out that articles found of very high value shall also be forwarded to the IRSE (UK) & other international technical journals for international recognition.

BASIC DIFFERENCES IN SIGNALLING AND ITS DEVELOPMENT ON INDIA, UK AND US RAILROADS

by :
ANSHUL GUPTA
GM (Marketing), RailTel

Basic Signal Meanings

On railways all over the world, signals are used to indicate to the driver of a train how he should proceed. The way this is done in the US (and most of Europe except UK, Spain and Norway) is quite different compared with the India. Though signalling on UK is more or less similar as on India. In India and UK (and other countries using UK based systems), signals are designed to show the driver the state of the road ahead. For example, a signal will show that the line is clear ahead and may also indicate as to how far ahead it is clear. The driver, using his knowledge of the line and of the train he is controlling, will make a judgement about how fast he can safely let his train go and will proceed accordingly. In the US, signals show drivers the speeds they are allowed to go. They do not actually need to know how far ahead the line is clear. The speed they are allowed to do will depend on the type of train the driver is controlling.

ABS and Interlockings

In the US, like in India and UK, signals are classified into two general types. In the UK they are referred to as automatic and controlled, in the US they are known as Automatic Block Signals (ABS) and Interlocked signals respectively. In India also they are known as Automatic Block Signals (ABS) and Interlocked signals respectively The two classifications are similar in that automatic signals work without manual controls while controlled or interlocking signals usually cover junction areas and require some form of additional controls operated by a signal tower (signal box in UK) or control room or Power cabin.

Overlap or Safety Block

Another feature of US railroad signals is that they do not have the 200 yard overlaps that are normal in the UK. India uses UK concept. The usual method of providing a safety margin beyond a stop signal in the US is to allocate the whole of the next block as the overlap. This is similar to the principle adopted on metros which use ATP.

Bi-Directional Signalling

Most of the US lines are equipped with full bi-directional signalling. You will often see a block boundary with two signals, one facing in each direction. The signalling operates exactly the same, regardless of the direction of running. In India and UK it depends on the traffic.

ATS, ATC, CSS

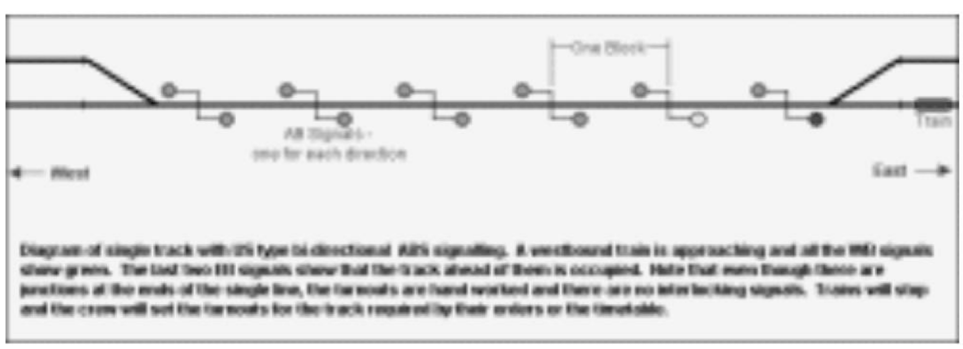
Any operator in the US who wants to run trains over 79 m/hr has to have some sort of automatic train stop (ATS), automatic train control (ATC) or cab signalling system (CSS). These names all mean that the driver gets some sort of in-cab indication and a warning of signal conditions. There are basically two systems; those which provide a warning like the UK AWS or recent TPWS system and those which regulate speed, like an ATP system. In India there is no such regulation. However, as per Signal Engineering Manual at spedds above 140 Kmph TPWs is desirable.

Dark Territory

In the US, there are still large sections of lines which have no signals. This is almost unheard of in UK and Europe because train traffic is normally a lot more dense. In India there are lines having no signalling or rudimentary signalling systems. In the US, the unsignalled lines are usually long, single line sections in remote areas and there are thousands of miles of them. They are commonly referred to as dark territory. Trains are permitted to pass from one area to another by the use of train orders or track warrants, nowadays transmitted by radio between dispatchers and train crews. Passing loops, called sidings in the US, usually form the boundaries between areas. There are elaborate rules for ensuring safety and accidents are rare. India have one engine only or one train only system with paper / baton authority for train control.

Single lines with Signals

Some single line sections in the US are equipped with ABS (automatic block signals) to allow two or more trains to follow each other closely along the single line between sidings. The signals are provided for both directions as shown in the diagram below. Often, the entrances to sidings are not controlled by interlocking signals and turnouts for sidings (passing loops) are hand operated.



There are no signals at the entrance to the signal line (diagram left). The crew will be given authority by Track Warrant over the radio to enter the single line and then they will observe signals. The reason for this type of operation is to allow more than one train to proceed along the single line. Without the signals, successive trains have to follow by time interval, a rule still used in North America but which has not been allowed in the UK or India in last century.

Diagram of single track with US type bi-directional ABS signalling, where two westbound trains are passing through. Note the sequence of signals on the WB side but that all the opposing EB signals have switched to red ahead of the WB trains.

The next diagram shows the sequence of signals as two westbound (WB) trains pass through the single line section. The signal indications are similar in meaning to the British "stop, caution or distant and clear" indications.

Turnouts

On main lines mostly motor operated switch operation is prevalent.. On single lines in the US, it is not unusual for sidings to be equipped with hand operated turnouts (points), even if the line is equipped with automatic signals. This means that the driver of a train approaching a siding has to stop his train, even if the signal is showing a "proceed" aspect, and operate the turnout by hand to enter the siding.

Some sidings have spring loaded turnouts which are set to ensure that trains from opposite directions enter a different track without the crew having to stop and set the turnout by hand. In India the operation of turnouts is again mixed. On section having high density of traffic generally points are motor operated.

Operating Philosophy

In the UK, trains have been regulated by fixed signals since shortly after railways were first opened in the early 19th century. As signals in the US were the exception rather than the rule, many railways' rulebooks reflect this in their treatment of the rules. Signals were (and still are in some places) regarded as an adjunct to the railway rather then part of it. With this in mind, we can now look at US signalling in general.

US Signal Layouts

A train passing along a signalled route will see an arrangement of signals which will appear somewhat as described in the following paragraphs. Every 2 miles or so the train will pass an Automatic Block Signal (ABS). All ABS signals for all tracks and both directions are located right next to the block entrance at the insulated rail joint (IRJ). So, as the engineer (driver) passes from block to block its almost like passing through a pane of glass. This is enhanced by the fact that for the most part there isn't much along the wayside but at a block limit he will see signals, relay boxes and rail joints. The driver is passing block after block and all the signals have one head but then he gets to a block limit where the signal in his direction has two heads (direction) These are the distant signals for an interlocking. They are still automatic and still retain a number plate that ID's them as automatic. After proceeding a little farther down the line the engineer reaches the interlocking entrance. Across all tracks, in his direction only, is a line of signals. These signals have two or three heads and no number plate, which ID's them as absolute (stop) signals. If there is a proceed indication, the train crosses the boundary defined by the IRJ and signals and enters the interlocking. The train then rumbles over the points, it passes the signal tower or relay shed, rumbles over some more points and reaches the "exit" signals. The exit signals actually have no bearing on this train whatsoever because they are all facing the opposite direction for incoming trains.

The entrance signals not only govern the interlocking, but also the next block. However the exit signals and associated IRJ define another boundary and, after the train completely passes this boundary, is it out of the interlocking, free of dispatcher control and under automatic signal rules. Note that, while any part of the train is between the Home (entrance and exit) signals, it is working under interlocking rules. Once it crosses the boundary defined by the Home signals it is under rule 251 or 261 operation.

The train continues on to complete the same steps through each interlocking. Every so often a train will pass from one interlocking right into another (some interlockings also have sub interlockings that are completely independent). The first ABS limit the train reaches will be the distant for operation in the other direction.

Signalling Commands

The US Automatic Block Signal (ABS), i.e. one without any manual control and operated by trains passing through track circuits, shows four basic commands. The way they are shown, in other words the aspect, varies from railroad to railroad and often from division to division in a railroad. There are also variations in the meanings of signals which appear to look the same. The basic commands, however, are:

- **Stop, Approach, Approach Limited and Clear.**

The US has the "stop and proceed" signal system. Somewhat similar system may be "permissive" signal on Indian Railways or in UK. The driver is told, "You are allowed to pass this signal after stopping but you must proceed at a speed which allows you to stop your train in half the available sighting distance." There are some stop signals at interlockings (therefore they are not ABS) where it is forbidden to pass and these are called "absolute stop" signals. They invariably show a different display to the permissive stop signal and it normally includes two red lights.

As US signals are speed limiting, a signal displaying "Approach" means the equivalent of the UK single yellow - "be prepared to stop at the next signal" but, additionally, the US rule says, "also keep your train speed down to less than 30 mi/h (often less for freight)". "Approach limited" (UK = double yellow) would mean "you should be doing 30 by the time you get to the next signal but not more than 45 mi/h now".

In the US also, there are three common terms used to instruct crews about permitted train speeds. These can be classified as "slow","medium" and "limited". Slow normally means less that 15 mi/h, medium normally means 30 and limited means 45 (40 for freight) mi/h. There is a fourth "Restricted Speed" which is 15 mi/h inside interlocking limits or 20 outside or the speed which allows you to stop within half sighting distance. It is the speed you are allowed to do if you have passed a red permissive signal.

There is a list of the common signalling rules applied to most railroads in North America at NORAC Signal Aspects. It shows each signal display and the rules appertaining to that display.

- ***Interlocking Signals***

Interlocking or controlled signals in the US represent the interlocked signals in India or "controlled signals" in UK.; i.e. one that is controlled from a signal tower (cabin in UK) or any sort of control room. Interlocking signals offer a great variety of signal displays and commands which can be confusing. In addition to signals showing what speed you are allowed to do because of the route which is set for you, there are some which indicate a speed restriction "within interlocking limits".

A sample series of commands looks like this: Note that the commands are all speed related and they cover AB signals as well.

Clear - Proceed at normal speed for your train, you will get the straight route ahead.< /br> Approach - Be prepared to stop at the next signal and reduce train speed to 30 mi/h< /br> Approach Slow - Be prepared to stop at the next signal but approach it at slow speed (15 mi/h); usually because of passing through a crossover.< /br> Advance Approach Medium - Proceed but approach second signal ahead at medium speed (30 mi/h)< /br> Approach Medium - Proceed but approach next signal ahead at medium speed (30 mi/h)< /br> Approach Limited - Proceed but approach next signal ahead at limited speed (45 mi/h)< /br> Limited Clear - Proceed but at limited speed (45 mi/h) within interlocking limits< /br> Medium Clear - Proceed but at medium speed (30 mi/h) within interlocking limits< /br> Slow Clear - Proceed but at slow speed (15 mi/h) within interlocking limits

There are some variations for different railroads but the range of speeds is similar.

The speed commands are displayed in a bewildering variety of signal aspects, some of which are shown below.

"Approach"

It is worth adding a few notes here about the use of the word "approach" and how it is applied to US signals. Approach is the US term which would be known as "caution" in the UK. Approach Medium, Approach Limited and Advance Approach are all commonly used to describe certain types of signal commands in the US. There are basically three types of Approach signals: "Approach ....", "............ Approach" and just plain "Approach".

Approach tells you how fast you have to be going by the next signal only. Except in the case of Approach Slow, they say nothing about how fast you can go before the next signal. Also an "Approach ...." signal informs the driver that the next signal is not at Stop but also not at full Clear. For the interests of safety, trains with ATC are limited to 45 mph or less after passing any type of "Approach ...." signal but, going by the letter of the rules, the driver must only be doing the proscribed speed by the next signal. Furthermore, while trains with ATC are limited to 45 mph after passing both an Approach Medium or an Approach Limited, trains which pass an Approach Medium must slow to 30 mph by the end of the block, while trains which pass an Approach Limited can continue to travel at speeds up to 45 mph.

A "............ Approach" signal tells the engineer to reduce speed at once and then to expect a stop signal. In the case of Medium Approach the driver must begin to reduce to medium speed as soon as the Medium Approach signal becomes visible. This also serves as an informal overlap.

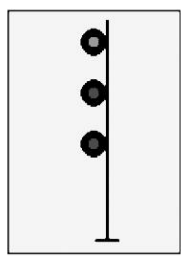
A simple Approach signal tells the driver to expect stop in one or two blocks and proscribes an immediate speed reduction. Advance Approach and Approach Medium or Limited are not always used interchangeably. Approach M/L makes use of signals with two or more "heads" but if you want to install three-block protection then it's easier to use Advance Approach.

Advance Approach proscribes a speed limit of 45 mph while Approach M/L doesn't. Approach M/L implies non-stopping signals ahead while Advance Approach implies the second signal is red. In the US, with huge freight trains the engineers really need plenty of time to prepare to stop and therefore they need signals that give them warning of a stop and others that warn them of a required slow-down.

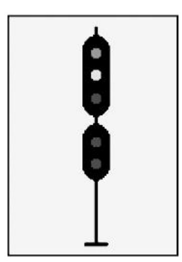
"Approach ...." signals are most often used to indicate that a train will be taking some form of diverging route at an interlocking. Advance Approach signals warn of a stop in two blocks, Approach warns of a ABS (permissive) stop at the next signal and Medium Approach warns of an absolute stop at the next signal.

Types of Signals

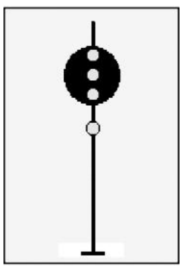
As we have seen, there is a wide variety of signals in the US. Each R.R. originally had its own system but now, due to mergers, take-overs and split-ups, you can expect to find a mix of signals on any system. A display of the main types follows.



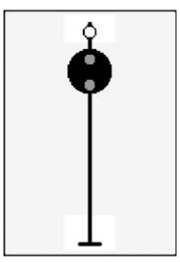
Searchlight signal common in the US and originally favoured by such railroads as the old AT&SF section of the BNSF. The lights are capable of displaying more than one colour. Some ABS examples have only one light to display green, yellow or red. This example is showing "clear" through an interlocking. Note that all US signals show speeds permitted, so that routes are not normally indicated by "feathers" (a row of white lights) above the signal. A route may be indicated by the vertical arrangement of aspects, so that Green over two reds indicates the main route whilst red over two greens means diverging route. Unlike the UK, all aspects are lit even if this means showing green and red together.



US colour light signal showing possible light displays. This type of signal is different from the AT&SF type shown above and is more akin to UK practice in that aspects not required are not shown. This diagram just shows the possible aspects. They are not all displayed together.



Position light signal beloved of the Pennsylvania R.R. The system emulated the old 3-position, upper quadrant semaphore system once common in North America. Three vertical lights means clear, diagonal lights means caution and horizontal lights means permissive stop and is usually accompanied by the yellow light below. The absolute stop lights are also horizontal but now usually red.



This is the colour position light system now used by Amtrak. It also emulates the semaphore signal system but with the addition of colour and only two lights for each position. The white light above the main display is extinguished when the two horizontal reds are shown if the stop is absolute.

Finally, a position light dwarf signal used by the old PRR. It looks very similar to the shunt signals used in India and in UK.

The Imposition of ATS/ATC

The US uses automatic train stop (ATS) or automatic train control (ATC) on busy lines or where higher speeds are required. ATS is similar to the UK AWS while ATC is a form of automatic train protection (ATP), as it is called in the UK.

In 1922, the US Interstate Commerce Commission (ICC) told railroads that it wanted them to install some sort of ATS or ATC on hi-speed lines as a safety precaution. The ICC made no regulations at first but it warned that it would do so in the future. Initially, several companies began to build ATS/ATC systems but then the depression of the 1930s, followed by WW2, slowed development. In 1951, the ICC made good on its word and mandated a nationwide 79 mph speed limit on any track not equipped with some sort of ATC/ATS. By this time many Americans had bought cars and given up on train travel so a number of railroad companies felt that ATS/ATC was not worth it and just accepted the speed limit but there were a few notable exceptions. These included the Pennsylvania R.R., which was a firm believer in safety systems.

The 79 mph speed limit is still in effect, although on some lines in the western US Amtrak has received permission to go up to 90 mph. On the east coast it is illegal for any non-CSS (Cab Signalling System) equipped train to run on CSS territory.

Types of ATS/ATC

ATS operates from track mounted inductors. At the first restrictive signal, the inductor acts to operate a warning noise for the driver who has a few seconds to acknowledge it and start braking the train or there is an automatic brake application. The system is sometimes used with cab signalling (called CSS), where the signal displays are shown in the cab. This requires a continuous track to train transmission system. On some lines equipped with cab signalling, there are no wayside signals.

ATC requires continuous track to train

transmission since the speed of the train is being constantly monitored and cab signal displayed to the driver. If speed limits required by the signal displays are not adhered to, the ATC system will apply the brakes. ATC also operates over lines which are not equipped with wayside signals.

Here's how the system works: As a train passes signal A at the start of the block, a CSS coder at the end of the block sends the CSS code into a rail. The code consists of pulses of 100 Hz AC, 180 pulses for Clear, 120 for Approach Limited, 75 for Approach and 0 for Restricting or Stop.

The largest user of ATC with cab signal and with wayside signals was the Pennsylvania R.R. (PRR). The PRR had always been a leader in safety and was one of the first RRs with air brakes and knuckle couplers as standard. In the 1920's the PRR was busy electrifying and replacing old semaphore signals with yellow position light signals. They listened to the ICC and decided to install a Cab Signalling System on all main routes. This grew to include over 1100 route and 3000 track miles.

FIRST COMMERCIAL APPLICATION OF ERTMS/ETCS LEVEL 1 : LESSONS LEARNED

Excerpts from the Article
by :
MARTIN POTTENDORFER
DIETRICH RHEIN

Introduction

Over the past ten years, the European Union has cooperated closely with the railway and signaling industries to specify a future standard European Train Control System (ETCS). The simplest application level (ETCS level 1) of this system uses track-to-train transmission based on magnetic transponders (Eurobalises). The level 1 variant can be easily implemented as an overlay to an existing lineside signaling system controlled by route setting and interlocking systems. This application level provides enough performance for continuous train supervision and train control at conventional speeds of up to 200 km/h, with transmission of information from the track (spot transmission). As shown elsewhere, it has many advantages and is easy to implement on existing railway lines [1]. The first commercial deployment of this system was undertaken by Alcatel in a project on the sofia-Burgas line for the Bulgarian State Railways (BDZ). Further details of this project can be found in [2].

ETCS level 1 consists of a lineside part and an onboard part, as shown in *Figure 1.* The former consists of Lineside Electronic Units (LEU) and Eurobalies. In a decentralized approach, the LEU detects the signal information and transmits to the trains, in a fail-safe way, telegrams containing movement authorities, track data and other

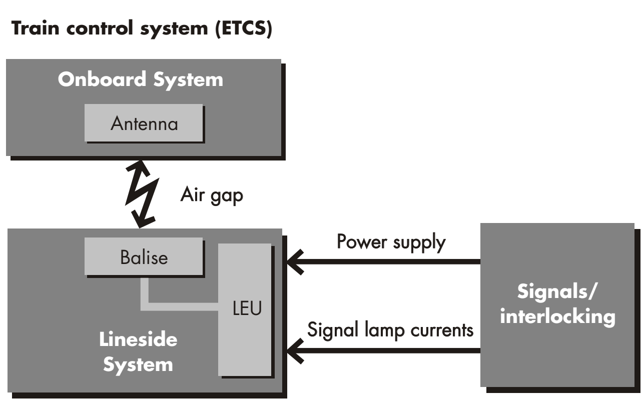


Fig. 1 Train control subsystems

information specified in the ETCS standard [3]. The onboard system receives this data and provides cab signaling to the driver. Furthermore, it continuously monitors the train speed and, if necessary, applies the service brake and /or the emergency brake to guarantee the safety of the train.

Lineside System

Lineside system overview

The ETCS lineside system transmits to the trains the movement authority together with relevant track data and conditions, such as static permitted speed profiles and gradient profiles according to the route set by the interlocking system. Transmission is performed by the Eurobalises in compliance with the Eurobalise interface A specification [4]and the ETCS language for track-to-train packets and telegrams [3].

A decentralized approach was chosen for the Bulgarian system; the lineside equipment is located at the signals to detect the lamp currents and does not interface directly with the interlocking system. Compared with a centralized approach in which the LEUs are controlled via an interface with the interlocking system, this solution has the advantages of minimum influence on the existing signal system and much less cabling. The disadvantage of missing route information at some signal locations can be compensated by explicitly transmitting information telling the train which route has been chosen. These telegrams can be placed either in additional balise groups (repositioning balise groups) or in the balise groups of existing lineside signals (i.e. signals used for the opposite direction).

According to the European Rail Traffic Management System (ERTMS) / ETCS requirements for the implementation of ETCS level 1 with spot transmission, the lineside system comprises :

- lineside electronic units;
- balise group consisting of one or more Eurobalies.

Two types of data transmission point are used (see figure 2).

- *Variable data transmission point* is normally used at each signal. It consists of one LEU and a group of atleast two balises, normally one fixed and one switchable balise. In this case, variable information is fed from the LEU to the switchable balise via a cable. The telegrams are prepared off-line and the telegran relating to the current signal aspect is selected by the LEU.

- *Fixed data transmission point* is normally used at locations where permanent data has to be transmitted to the train, such as entry/exit points (where an area equipped with ETCS begins or ends), temporary speed restrictions, and location references. This transmission point normally consists of a group of one or two fixed balises.

Usually each balise group can transmit information that is valid for the nominal direction as well as valid data for the reverse direction. Special measures are taken to ensure that the information transmitted by a balise group is correctly interpreted according to the direction in which it is passed. Each balise group is assigned a unique identity number and is linked to the neighboring balise groups. Balise linking is used by ETCS to detect

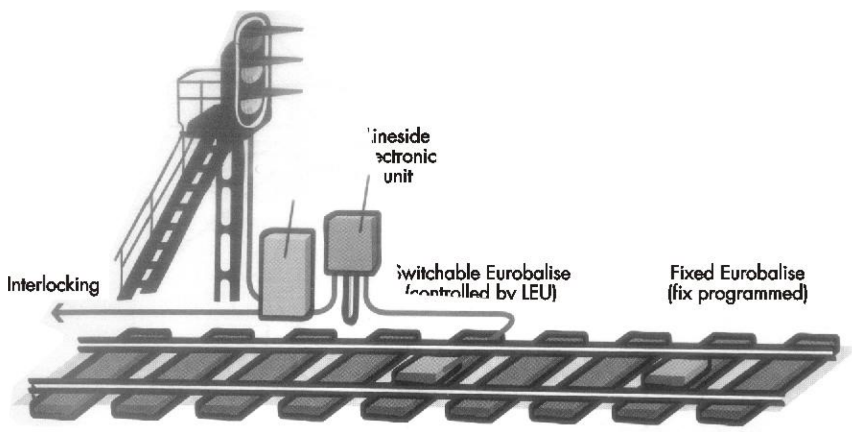


Fig. 2 Lineside equipment at a signal

transmission errors (e.g. missing balise group).

Limeside electronic unit

The LEU detects the signal lamp currents (without affecting the lamp circuits), calculates the corresponding signal aspect, selects a related predefined coded telegram and forwards its code continuously via a serial link (interface C according to [4]) to the adaptation balise. For safety reasons, the signal adaptation circuits and telegram selection are arranged in two independent hardware and software channels; a valid telegram can be transmitted to the output only if both channels have detected the same signal aspect. If a failure occurs, a default error telegram is sent to the connected balise.

The structure of the Alcatel LEU follows the Alcatel safety strategy, as shown in *figure 3.* The hardware consists of a ground/connector board, a signal adaptation board and a micro-controller board. The functions are performed in two independent hardware channels using some degree of software diversity to avoid common errors, compared to avoid common errors and the results are then compared to avoid single failures.
The signal adaptation board can detect the currents in six lamp circuits. It consists of low input impedance current transformers, multiplexers (used for periodic calibration of the amplifiers), amplifiers and signal filters, as well as power supply filters for internal use. The software in the micor-controllers controls the measurements and periodic calibration, and safely performs all the unit's logic functions [5].

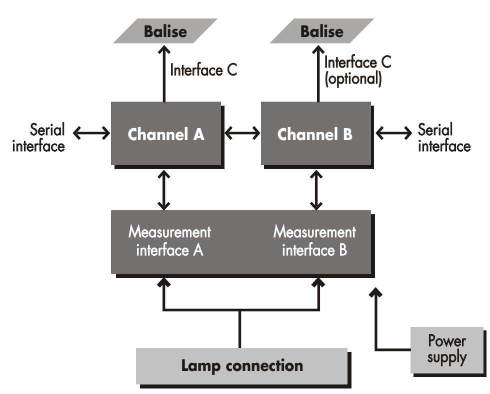


Fig. 3 Structure of the LEU hardware

Centralized LEU

In some ETCS level 1 applications, customers request centralized control of the LEUs via interface with the interlocking system. The advantages of this approach compared with the decentralized approach with LEUs at each lineside signal are as follows:

- Status of the related signal is provided directly by the interlocking system, making it unnecessary to detect the lamp current.
- Speed and route information can be provided.
- No time delay in making and evaluating the measurements (which could be up to a few seconds at aspects with flashing signal lamps).
- Telegrams can be downloaded to the LEUs from a control center, for example, in the event of changes resulting from temporary speed restrictions in contruction areas.
- Status information from the LEUs and error messages are available at the control center.

The main disadvantage of this approach is the higher cost for an additional computer system with safety responsibility acting as an LEU controller, a network connecting all the LEUs with the LEU controller, and the cabling needed to install this network. The latter may be acceptable for new lines or for reconstructed infrastructures where the cables can be installed at the same time as other works.

Eurobalises
Standard Eurobalises were used in the ETCS project for the Bulgarian State Railways. These Eurobalises comply with the Consortium of European Railway Signaling Suppliers (UNISIG) specifications on both the A and C interfaces. They are standard components and can be provided by various suppliers. The programming of fixed telegrams into fixed balises and of the default telegrams into switchable balises is done using a Eurobalise programming and test tool.

Lineside data preparation and verification tool
A lineside data preparation and verification tool, known as ETCSPro, has been developed to perform the following tasks :

- collection of lineside data;
- definition of a project, main lines, topology and transmission points;
- planning of route aspects and profiles (speeds, gradients);
- generation of telegrams and loadable files (LEU configuration files, encoded telegram data files);
- generation of transmission point reports for verification.

This tool, which runs off-line on a PC or notebook, enables the user to define the topology and all necessary data, while the tool calculates the telegrams for all balies and signal telegrams and fixed telegrams)

Onboard System

Onboard system overview
The Onboard system components are illustrated in *Figure 4* and described in the following subsections.

European vital computer

The European vital computer (EVC) is at the heart of the AlTrac onboard system. It

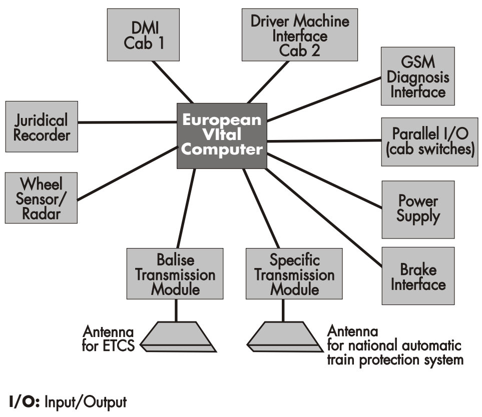


Fig. 4 Alcatel 6413 AlTrac onboard system configuration

manages all the information received from the lineside and from other onboard equipment, and performs the data processing and train monitoring in a way that ensures the safety of train movements under all circumstances in accordance with the ERTMS/ETCS specifications [3]. The development follows Alcatel's safety strategies, including :

- Two independent hardware channels with software comparison of all safety-related decisions.
- Use of the software platform for vital systems to provide real-time processing, communication and fault-tolerant capabilities.
- Diverse application software in the two independent processing channels.
- Safety assessment and approval according to European Committee for Electrotechnical Standardization (CENELEC) standards [6,7].

EVC Hardware

The EVC hardware consists of

- Two main processor boards: 2-out-of-2 vital computer, based on embedded CPUs.
- Two AlTrac interface controller boards.
- Input/output adjustment board controlling all interfaces of the system with the locomotive.

The EVC hardware is implemented in Alcatel standard 19" equipment practice (*see Fig. 5*) (black box) and the power supply unit are housed in the EVC cabinet, but are not part of the EVC.
Because it is necessary to interface with different types of locomotives, the two AlTrac interface computer modules and the power supply unit have different configurations.

EVC Software

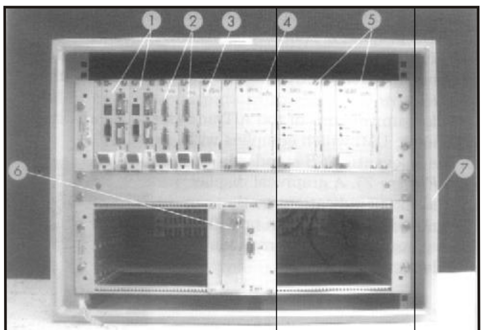
The EVC software supervises the system status calculates the maximum permitted speed and distance to the next speed change, and displays them on the Driver-machine Interface (DMI). If the speed is too high, first a warning is given; the brakes are activated automatically when the relevant limits have been exceeded. The EVC software consists of three main parts:

- TAS Platform comprising the operating system, the fault-tolerance and communication technology for safety-related control systems. The TAS platform is used in many other Alcatel products like electronic interlockings and axle counters.

- Applications software, consisting of a Channel A which performs all the vital and non-vital EVC functions, and a Channel B which supervises all the vital functions in a diverse way related to Channel A.

The software components are located on different EVC boards depending on the hardware architecture and in accordance with the requirement to realize a vital control system.

Peripheral components Alcatel 6413 AlTrac DMI



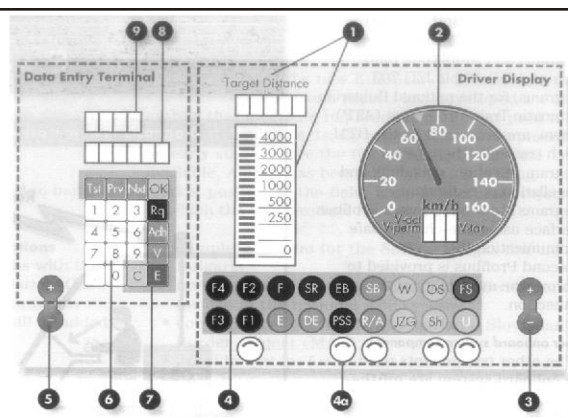
1. Main CPU boards
2. AlTrac interface controller board
3. Input/output adjustment board
4. Secondary power supply module
5. Primary power supply DC/DC converters
6. Judicial recorder (flash card locked behind the key)
7. EVC cabinet.

Fig. 5 View of the EVC cabinet with front cover removed

A special DMI was supplied by DEUTA, Germany, for the BDZ project: it combines a commercially available multifunction display (MFA21, which is also used in systems like LZB) with a suitable data entry terminal (*see fig. 6*). Follow-up versions of the AlTrac system use an ergonomic DMI which complies with all the relevant ETCS standards (*see fig. 7*). A graphical display is used for all indications to the driver, and a touch screen provides the means for driver interactions and data entry.

BTM and Antenna

The Balise Transmission Module (BTM) is a vital system that periodically receives information from the EVC about the current time, speed and odometer values. The BTM controls transmission of the balise powering frequency (27 MHz) by the antenna and processes the signals received from the balises. Both Frequency Shift Keying (FSK) Eurobalise telegrams and Amplitude Shift Keying (ASK) 12 bit JZG 703 telegrams, for the national Bulgarian Automatic Train



1. Target distance numerical display and bar graph display
2. Actual speed, permitted speed and target speed/release speed indicator
3. Indicator lamps (4) and digital display (1) brightness control
4. System indicator lamps and related push buttons (4a)
5. Speedometer (2) brightness control
6. Numeric keypad
7. Functional control buttons
8. Train data value, numeric display
9. Train data type, alphanumeric display.

Fig. 6 DMI of Alcatel 6413 AlTrac

Protection (ATP) system, are processed by the BTM, which transmits them (after telegram selection, decoding, and cancellation of redundant telegrams) to the EVC via a Profibus interface using one-channel safe communication [8].

Other onboard system components

The other components used in the onboard system are off-the-shelf components. They include the juridical recorder, wheel sensor brake pressure sensor and service brake control valve

STM operation on lines equipped with national ATP systems

One of the main advantages of the ETCS compared with existing ATP systems is its interoperability with the lineside equipment of differently equipped lines if the appropriate Specific Transmission Module (STM) is included in the system configuration. In this case, the train can move from a track equipped with Eurobalises to another equipped with the national ATP system, and vice versa and the supervision routines will change automatically.

AlTrac system for BDZ provides train protection and control on lines equipped with the national system JZG 703. The STM functionality is partially integrated in the BTM (see above) and in translates the JZG telegrams into ETCS packets, which allow train supervision in a similar way to ETCS level 1 with slightly reduced input data.

Different STMs are being used in other countries for instance, for the Hungarian State Railways (MAV) system, the second application of the AlTrac onboard system, an ATM has been developed for the Hungarian EVM track-circuit train protection system and integrated into the system (*see fig. 4*).

Integration of radio-based diagnostic system

AlTrac product family (lineside and onboard) continuously run self test and self diagnostic routines to check whether they are functional or not.

In addition to the self-diagnostic facilities, the onboard unit for the AlTrac product family includes a radio connected central diagnostic server to cover the entire ETCS level 1 control (*see fig. 8*). In this case, the onboard unit collects and filters diagnostic and alarm messages as an AlTrac equipped locomotive moves along the line. Standard mobile radio devices (such as the Global System for Mobile communication - Railways; GSM-R) transmit this data to a central diagnostic server, which can be located

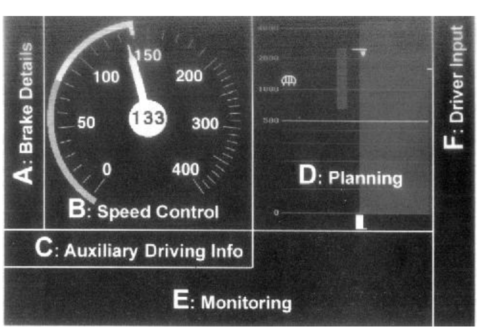
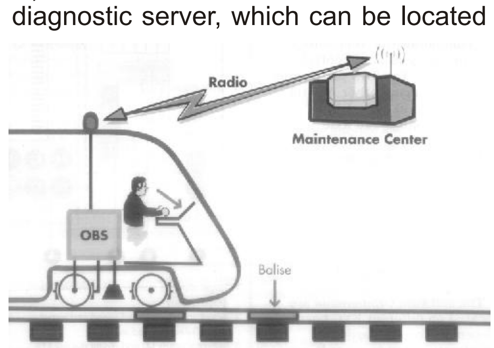


Fig. 7 DMI for the Alcatel 6413 AlTrac



OBS : OnBoard System

Fig. 8 Diagnosis system trackside - onboard

whereever the customer prefers. A comprehensive ETCS diagnostic overview can be established in quasi real-time by correlating the incoming dynamic data with the corresponding topological and lineside data.

Future System Upgrade

In the future, the product will be upgraded to include the following features

Full compatibility with the final ETCS specifications

Compatibility of the implemented functions with the ETCS UNISIG system requirements specification, Class 1,issue 2.2.2 has been achieved with the Hungarian project. However, some specific functions will be added in future developments.

Input/output flexibility of lineside equipment

For many specific or additional applications of the ETCS lineside system, the provision of digital inputs and outputs by the described LEU has been found to be necessary or convenient. Examples of the use of digital inputs are as follows:

- Detection of signal or route information directly from the relay contacts of interlockings (e.g. in case of group exit signals serving more than one track).
- Detection of external control signals (e.g. whether or not a level crossing protected).
- Detection of the status of a switch behind a signal (signaled speed with enhanced route information)

In addition to the outputs to Eurobalises, digital outputs may be required:

- To provide LEU status information for maintenance purposes.
- To control equipment external to the ETCS which depends on the detected signal aspect and/or the digital input information (e.g. simple fallback train protection equipment like INDUSI, PZB and MEMOR II)

For those purposes, Alcatel has specified and developed an LEU that can handle additional safe and non-safe digital inputs and outputs.

Speed measurement upgrade

The introduction of a radar speed sensor into the system has been started to increase the accuracy of the speed measurement which is often influenced by errors caused by wheel slip and slide. The first application will be in the Hungarian follow-up project for the Hegyeshalom - Budapest line.

Conslusion

Deployment of the new European train control system has just started. Examples of the projects in which the new product has been used are :

- complete system for the Sofia - Burgas line in Bulgaria.
- lineside system for the Seetal line in switzerland for use in the national ATP system.
- complete system for the Luxemburg rail network (CFL);
- lineside system for the Austrian Federal Railways (ÖBB)

These examples illustrate the flexibility of the product for interfacing with different signaling systems and locomotive types.

References

[1] A. Veider, H. Boyer, D. Rhein, A. Zierl: Betrieblich optimierter Einsatz von ETCS-Level 1*, *Signal and Draht 94,* no *7/8,* pp 13-18, 2002.

[2] D. Rhein: *The first implementaion of ERTMS/ETCS Level 1*, in: J. Allon, R. J. Hill, C. A. Brebbia, G. Sciutto, S. Sone (editors), *Computers om Railways Vill,* WIT Press, UK, 2002, pp 13-22.

[3] ETRMS/ETCS - UNISIG Class I: "System Requirements Specification", Subset-026, issue 1.2.0 (july 1999) and issue 2.2.2.

[4] ERTNS/ETCS Class I: "UNISIG FFFS for Eurobalise", Subset-036, Issue 2.2.1.

[5] D. Rhein, C. Vinazzer: "ETCS Level 1 lineside system - the Alcatel solution", *Signal und Draht* 94, No 9, pp 58-65.

[6] prEN 50126: "Railway applications - The specification Maintainability and Safety, Availability.

[7] ENV 50129: "Railway applicatoins - Safety related electronic systems for signaling", May 1998.

[8] EN 50159-1: "Railway applications - Communication, signaling and processing - Safety-related communication in closed transmission system.

TELECOM - THE BREAKTHROUGHS

Compiled by :
ALOK AGNIHOTRI
AM/BD/RCIL, New Delhi

In the last couple of centuries, communications has seen many innovations and inventions. The pace of these has been incredible, at the very least.

1753: Charles Morrison proposes the construction of a telegraph consisting of 26 electrical lines, each corresponding to an alphabet. Individual letters were to be indicated by the movement of a light object, which was repelled when a current passed through one of the wires.

1791 : The optical semaphore signaling system, invented by Claude and Ignace Chappe to send each other messages while at school, is officially adopted by French legislature.

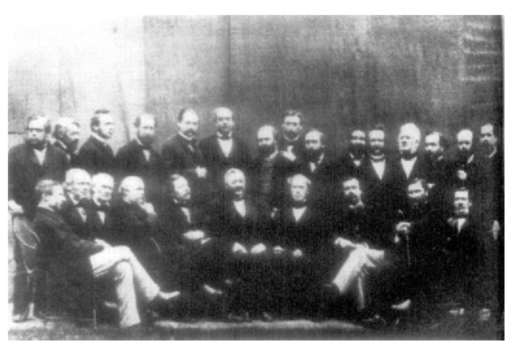
1793 : The first official semaphore telegram is sent on 15 August to announce the French victory over Austria via Claude Chappe's network of semaphore stations. Chappe coins the term "Telegraph" for his system of transmitting message.

1835 : Joseph Henry develops the basic principles of the telegraph which are put into more practical form 11 years later by Samuel FB Morse these include the electric relay and the use of the Earth as a ground

1837 : Prof Charles Wheatstone and William Fothergill Cook develop a needle telegraph. On 24 July, they successfully transmit a message between two places, almost two kilometers apart.

1837 : Morse patents his version of the telegraph. The idea to use an electromagnet for transmitting signals comes upon him during a transatlantic trip when he sees a demonstration of one.

Samuel Morse, investor of the telegraph



The first conference of ITU, 1865

1839 : Dr. WBO Shaughnessy, a medical practitioner in Calcutta, starts experiments in electric telegraphy.

1845 : Samuel Morse uses his telegraph system using his telegraph code to send a famous message from Washington to Baltimore “What hath God Wrought?”

1851 : Siemens and Halske lay the first submarine telegraph cable from Dover, England to Calais, France.

1852 : The first telegraph line in India is laid from Calcutta to Diamond Harbour.

1855 : Telegraph service becomes available to public in India.

1862 : The Indo-European Telegrapg Department was formed to join India to the telegraph network.

1865 : The forerunner of the International Telegraph Union (ITU) is established on 17 May (observed as World Telecommunication Day). 20 countries agree to cooperate in telegraph communication.

1866 : First transatlantic submarine telegraph cable laid between the US and France by the legendary cable ship. The Great Eastern.

1870 : First submarine cable link to India established from London to Bombay.

1874 : Thomas dison and Alxander Graham Bell independently develop different types of multiplexed telegraph. While Edison's Perfected Quadruplex Telegraph could transmit simultaneously four messages in each direction over the common pair of telegraph wires, Bell's could simultaneously transmit two or more musical tones

1876 : Telephone is invented. Alexander Graham Bell gets the patent for it. Elisha Gray misses it by three hours.

1877 : John Kruesi builds the first phonograph, on the basis of Thomas Edison's sketch. The first recording is of Edison reciting, “Mary had a little lamb”.

1878 : The first commercial telephone exchange opens in New Haven, Connecticut.

1879 : London gets its first telephone system as Bell Telephone opens its first exchange. Edison forms the Edison Telephone Company Ltd.

1880 : Alexander Graham Bell transmits a sound over light beams for a short distance. He calls the device photophone

The Great Eastern, the legendary cable ship, 1866

Celebration on the opening of first submarine cable to India, 1870

Birthplace of telephone

and terms it his greatest invention, “greater than the telephone.”

1882 : Telephones arrive in India as a 50-line manual exchange is installed in Calcutta.

1882 : Lars Magus Ericsson introduces the telephone nicknamed the “Dachshund,” the first telephone for which handset combines the microphone and earpiece and rests on a cradle.

1885 : Indian Telegraph Act that is still in force, introduced.

1887 : Heinrich Rudolf Herz produces radio waves.

1892 : Almon B Stowger, an undertaker, invents the first practical telephone switching system, in which the caller determines who the receiver will be without the aid of the human operator. This leads to the dial telephone.

1895 : JC Bose is able to transmit through wireless. Boss never got the recognition as the inventor of wireless.

1896 : An unknown inventor develops the telephone dialer. Earlier, telephone connections were made through a telephone operator.

1896 : Hollerith establishes Tabulating machine Company, which later changes to International Business Machine (IBM).

1899 : Guglielmo Marconi establishes the first radio link between English and France tramsmitting greeting to the French scientist Edouard Branley.

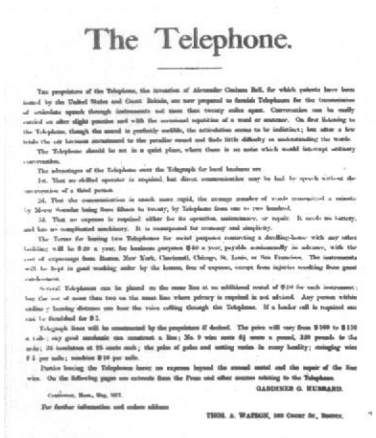
1901 : The first transatlantic telegraphic signal transmission takes place as Marconi receives the letter “S” in St. Johns, Newfoundland, that has been transmitted from English.

1903 : Bell Telephone company starts research in developing an automatic telephone switching system.

1903 : Coin collecting pay telephones are introduced in New York. The collection was a single shot model and the charge for a local call was 10 cents.

1905 : Marconi invents the directional radio antenna.

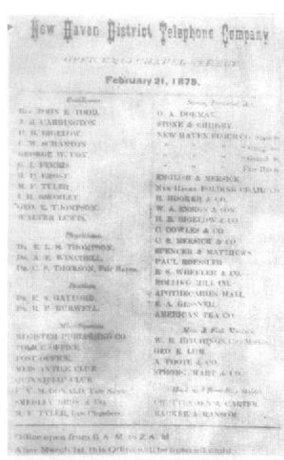
1906 : Reginald Aubrey Fessenden uses high-frequency alternator to transmit music and voice via radio waves to ships at sea that he has equipped with receivers. Fessenden calls it “wireless telephony”.



The Telephone.

GARDINER G. HUBBARD.

First telephone ad, 1877



New Haven District Telephone Company

February 21, 1878.

First telephone directory, New Haven, Connecticut, 1878

1906 : Lee DeForest gets the US patent (No 879,532 titled “Space Telegraphy”) for vacuum tube amplifier. This revolutionizes telecommunication systems.

1907 : Mississippi in the US becomes the first state to regulate telecom services.

1908 : General Electric develops 100 KHz, 2 KW alternator for radio communication purposes.

1909 : Marconi of Italy and Karl Ferdinand Braun of Germany win the Nobel Prize in physics for wireless telegraphy.

1910 : The first automatic exchange established in the US.

1913 : Edouard Belin invents the portable facsimile machine (fax) which he calls Belinograph and is capable of using ordinary telephone lines.

1913 : AT&T commits to the Attorney General to dispose of its telegraph stock, provide long distance connection to independent telephone systems, and not to purchase any more independent telephone companies except as approved by the Interstate Commerce Commission. This letter from AT&T to the Attorney General of the US is referred to as the Kingsbury Commitment.

1914 : Belin's portable fax machine is used to senf the first remote photo news story from the World War I over the telephone lines.

1914 : AT&T sells its holdings of Western Union Telegraph Company stock to comply with the Kingsbury Commitment.

1915 : 25 January marks the official ceremonies to open the first transcontinental line from New York, speaks to Thomas Watson in San Francisco repeatingthe first complete sentence transmitted by telephone, “Mr. Watson, come here, I want you.”

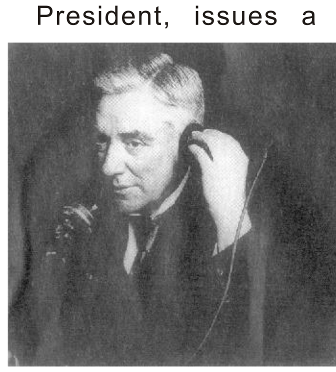
1915 : Overhead telephone cable disappears within the city of London and Birmingham with the laying of underground cables.

1915 : The first transatlantic radiotelephone conversation takes place between Arlington, VA, and Eiffel Tower, Paris.

1917 : Telephone transmission from airplane to ground is demonstrated.

1918 : Woodrow Wilson, the then US President, issues a proclamation

First Los Angeles telephone pay station, 1899



Thomas A Watson, receives the first long distance call at San Fransisco from AG Bell in New York. Bell repeated the same words that he transmitted over their first instrument, "Mr. Watson, come here. I want you"-25 January, 1915

assuming control of the telephone and telephone and telegraph systems in the US, placing them under the direction of the Post Office Department.

1922 : Graham Bell dics at his summer home, Beinn Breagh, near baddeck, Cape Breton island, Nova Scotia on 2 August. On 4 August, telephone service is suspended for one minute on the entire telephone system of the United States and Canada, during the funeral services of Graham Bell.

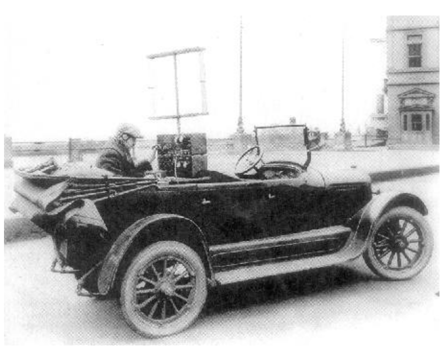
1923 : A group of India entrepreneurs Sir Rahimtoola Chinoy, Sir Cursow Wadia, Sir Ness Wadia, Sir Ibrahim Rahimtoola, and Sir Purushottamdas Thakurdas establishes the Indian Radio Telegraph Company.

1924 : On 19 May, Bell System engineers publicly demonstrate the first transmission of pictures over telephone wires.

1925 : Western Electric Research Laboratories and part of the engineering department of AT&T are consolidated to form Bell Telephone Laboratories, Inc.

1925 : AT&T introduces commercial wirephoto service.

1926 : John L Baird produces television images of moving objects and succeeds in transmitting pictures over telephone lines between London and Glasgow



Mobile radio telephone, 1924

1927 : A public demonstration of television by wire from Washington, DC to Bell Telephone laboratories in New York City is made.

1927 : The first picturephone conversation takes place. The device allows transmission of pictures as people speak.

1927 : On 23 July, Lord Irwin sends the first wireless telegraph from India to King George V in London.

1927 : Ralph VL Hartley introduces the concept of information as a measure for the quantity of data in a message.

1928 : Teleprinter is invented and put to use by Siemens & Halskey in Germany.

1932 : Marconi discovers microwaves. The first application of such waves in radar takes place 10 years later.

1934 : The communications Act in the US becomes effective on 1 July. Approved by President Roosevelt, this act brought interstate telephone business under regulation by the Federal Communications Commission instead of the Interstate Commerce Commission.

1934 : Radar is invented in the U.K.

1936 : First coaxial cable is demonstrated.

1937 : The combined handset telephone introduced commercially.

1938 : The first crossbar central office installation goes into service at Troy Avenue, Brooklyn, US.

1938 : Konrad Zuse completes the first working computer to use a binary code.

1939 : George Stibitz and Samuel B Williams introduced allowing for simultaneous calls over a single pair of wires.

1941 : Zuse devices the first working universal computer controlled a by programme.

1942 : Bell Telephone Laboratories applies for a patent on an oscillator circuit which almost at once proved of great value in radar systems used in the War.

1943 : First electronic calculating device developed.

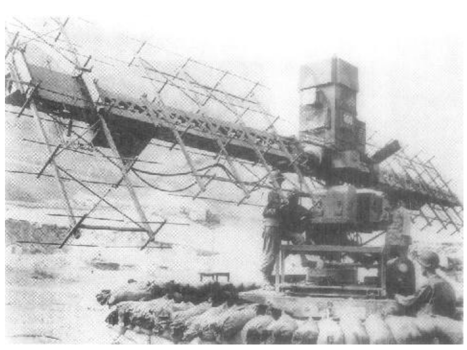
1944 : J. Presper Eckert and John Mauchly develop an early form of computer memory that stores data as acoustic pulses running down a tube filled with mercury.

1945 : Arthur C Clark purposes a geosynchronous satellite, which would hover over the same spot on Earth because it revolves at the same speed as Earth's rotation.

1946 : The first mobile telephones are introduced.

1946 : ENIAC, the first computer is officially launched.

1947 : Bell Labs scientists William Shockley, John Bardeen, and Walter H Brattain invent transistor. The world has never been the same again.



US Army's first radar, 1942

1948 : Claude Shannon, John R Pierce, Bernard M Oliver develop pulse code modulation.

1948 : Indian Telephone Industries (ITI) set up at Bangalore as independent India's first public sector unit.

1948 : The first cable television system introduced in the US.

1948 : IBM introduces the Selective Sequence Electronic Calculator which has electronic circuits for performing calculations and data storage.

1949 : On 14 January, the US Attorney General filed suit against AT&T Company and Western Electric Company, alleging violation of the Sherman Anti-Trust Act and asking that Western Electric be separated from the Bell System.

1949 : John William Mauchly develops the Short Code, which allows computers to recognize mathematical codes consisting of two numbers. This is considered to be the first high-level programming language.

1949 : Shannon publishes "The mathematical Theory of Communication", proposing that information is a measurable quantity and establishes the basic rules governing all kinds of communication including electronic forms.

1949 : Mauchly and Hohn Presper Exkert build the Binary Automatic Computer, the first electronic-stored program computer in the US.

1950 : Mauchly and Exkert found he first company setting out to commercialize computers.

1951 : Paging starts in New York, with no facility to page someone from the PSTN.

1952 : Bell introduces the first hearing aids equipped with junction transistors.

1955 : The first electronic switching demonstrated in Morris, Illionois.

1955 : Scientist Narender S Kapany, born in Moga, India, introduces the optical fibre. He discovers that a glass fibre surrounded by a cladding can conduct light over great distance with little loss of intensity.

1955 : IBM introduces the Semi-Automatic Business Related Environment (SABRE) connecting 1,200 tele-typewriters the first large network linked to a data base used by American Airlines for passenger reservation.

1956 : The first transatlantic telephone cable, linking Scotland with Newfoundland is put into operation.

1956 : A judgment delivered limiting Bell System to common carrier communications and government projects but preserving the long standing relationships between the manufacturing, research, and operating arms of the Bell System, AT&T retains Bell Laboratories and Western Electric Company.

1957 : On 4 October, USSR launches Sputnik I, the first artificial satellite Laika, the dog, travels to the space through Sputnik II the same year.

1958 : Bell System's Dataphone service, which permits high-speed transmission of data over regular telephone circuits is announced in January.

1958 : Jack St. Clair Kilby, an engineer at Texas Instruments invents the monolithic Integrated Circuits (IC)

1960 : Echo, the first passive communication satellite is launched, John Robinson Pierce, the man behind the project, feels that future of communication lies in satellities,

1960 : American physicist Theodore Maiman demonstrates the generation of a pulse of coherent red light by means of a solid ruby, the first laser. The idea, however, dates back to the days of Albert Einstein.

1960 : Customer trials begin of the world's first electronic Telephone Central Office in Morris, Illinois.

1960 : The first STD call in India introduced between Kanpur and Lucknow.

1961 : 16 January, Bell System proposes a new service called TELPAK which would create “electronic highways” between specific points, over which

Telestar Satellite, launched in 1962

Roland Mareno

many types of communications could be transmitted.

1961 : On 18 January, the FCC authorizes AT&T to operate experimental radio stations for basic earth satellite communications study (“Project Telstar”)

1962 : In March, the FCC approved “Bellboy” radio paging system on a developmental basis for use at the Century 21 World's Fair in Seattle. This marked the first commercial application of the paging system.

1962 : On 10 July, the world's first international communications satellite Telstar rocketed into space. First transmission came during Telstar's sixth orbit of the earth.

1964 : The first commercial communications satellite, Early Bird, is launched from Cape Kennedy on 6 April.

1964 : The first Soviet communications satellite, Molniya 1, which carries our transmissions of television programs, is launched.

1964 : First plans are drawn fro the Advanced Research Project Agency (ARPA) of the US Defense Department to establish ARPANET, a computer network that can connect different types of computers and that uses packet switching form of communication.

1964 : An International Telecommunication Satellite Organization (Intelsat) is set up by the US and 11 other countries to develop a global commercial satellite system.

1968 : The FCC renders “The Carterphone Decision”, a landmark decision. Under this decision, the FCC strikes down existing interstate telephone tariffs prohibiting attachment of connection to the public telephone system of any equipment or devise that was not supplied by the telephone companies (Bell System).

1969 : ARPANET, the precursor to Internet launched by the US Department of Defence.

1970 : On 26 June, the FCC in the US formally announces its place for regulating the cable television industry.

1970 : Intel introduces a memory chip that can store 1024 bits of data, replacing the voluminous ferrite core memories used by computers.

1971 : Direct telephone dialing as opposed to operator assisted calling begins between parts of US and Europe.

1971 : The first electronic mail is sent which becomes a common application over the ARPANET.

1974 : The Department of Justice in the US files an anti-trust suit against AT&T.

1974 : Frenchman Roland Moreno invents Smart Cards.

1975 : Bob Metcalfe writes his faous Ph.D thesis on LANs and then joins Xerox. He alongwith colleagues at Xerox, develops Ethernet, the most populat LAN standard till date.

1976 : AT&T installs its first digital switch.

1977 : First lightwave system is installed in Chicago, Illinois.

1977 : Cellular trials begin in the US.

1979 : The first commercial network of cellular telephones is set up in Tokyo, Japan.

1979 : The International Maritime Satellite Organization (Inmarsat) is formed to provide communication and navigation services via satellite.

1980 : The FCC issues its Computer

Inquiry II decision which differentiated between hasic and enhanced services. Basic services require regulation.

1981 : IBM introduces the desktop personal computer (IBM PC), Microsoft develops DOS for the PC.

1984 : Philips and Sony introduces CD_ROM, an optical disk that can store very large amounts of digital data.

1984 : The AT&T Divestiture creates seven regional Bell operating companies.

1984 : British Telecom is privatized.

1984 : Motorola sells its first portable cellular telephone.

1984 : IBM buys ROLM Corp., the US third largest business telephone system manufacturer and provider.

1984 : Manufacture of telecom equipment for the subscriber end opened to the private serctor.

1985 : Department of Telecom (DoT) and Department of Posts (DoP) separated in India.

1985 : Microsoft develops Windows for IBM PCs.

1985 : C-DOT, established by the Government of India to be a research organization, develops Rural Automatic Exchange (RAX), which revolutionizes Indian telecom spread.

1986 : The Overseas Communication Service (OCS) of DoT converted to VSNL.

1986 : Mahanagar Telephone Nigam Ltd. (MTNL) set up.

1988 : Thirteen European countries issued simultaneous tender for GSM equipment heralding a new era in communication.

1988 : The first transatlantic fibre optic cable is completed.

1990 : Tim Berners-Lee and Robert Cailliau, engineer of the European Organization for Particle Physics, part of the Centre Europe'en de Recheiche Nucle'aire (CERN), draft a proposal for an innovative “hypertext” information system, which they call the World Wide Web or W3 for the international high-energy physics community. The proposal is approved, and the World Wide Web is launched.

1990 : IBM sells ROLM Corp. to Germany-based telecommunications giant Siemens Corp.

1991 : Bell Labs develops photonic switching.

1991 : A small team led by James Gosling at Sun develops a programming language called Oak, which was renamed Java in 1994.

1992 : The Cable TC Act is introduced in the US to regulate CATV pricing.

1993 : The first digital mobile network is established in the US.

1993 : Europe sets 1998 as the date for full liberalization of its telecom markets.

1993 : The US National Centre for Supercomputer Applications (NCSA) releases the first browser to offer easy, point-and-click access to the World Wide Web. Called Mosaic, it makes use of the graphical interface concept familiar to Macinotsh and Windows users and is heralded as the “killer application” the Internet is waiting for. It is also free and can be downloaded from sites across the world. In the first year, NCSA estimates more than one million copies of Mosaic have been downloaded from their site alone.

1994 : Berners-Lee establishes the World Wide Web Consortium (W3C), Lee is concerned that, without an organization like W3C to develop common software standards and protocols, the Web will disintegrate into a number of proprietary and conflicting systems.

1994 : The National Telecom Policy announced in India. It opens the local telecom services for competition.

1994 : Commercial radio paging spectrum auctions.

1995 : The FCC in the US begins RF spectrum auctions.

1995 : Bell Labs develops Wavelength Division Multiplexing (WDM), which tremendously increases the capacity of optic fibre as a carrier of data.

1995 : Internet services launched in India

1995 : First cellular service launched in India at Clacutta by Modi Telstra.

1996 : The cable modem introduced as the number of US cellular subscriber reaches 40 million.

1996 : AT&T announces its second major divestiture by spinning off NCR and its equipment business (including Bell Labs) under the Lucent Technologies name.

1996 : The Telecommunications Act of 1996 in the US heralds a new era in telecom competition.

1997 : On 8 October, Nortel and Norweb Communications announce a new technology which allows data to be transferred over power lines.

1997 : Telecommunications Regulatory Authority of India (TRAI) set up for regulation of commercial communication services in India. It delivers its first judgment against the incumbent operator DoT.

1998 : Iridium, a global consortium led by Motorola starts Global Mobile Personal Communication (GMPCS) via satellite but runs into bad times.

1999 : India announces its new Telecom Policy in March 1999 which opens domestic long distance telephony and changes the licence fee regime

Bill Gates, CEO, Microsoft

A cellphone user in India, 1998

TRUEWAVE® FIBER AND CABLES

by :
LUCENT TECHNOLOGIES
Bell Labs Innovations

High Capacity Transport Systems

Today's high capacity transport systems employ Erbium-Doped Fiber Amplifiers (EDFAs) together with Time Division Multiplexing (TDM) and/or Dense Wavelength Division Multiplexing (DWDM) to maximize the total transmission capacity over one singlemode fibre.

Commercial TDM systems transmit at 2.5 and even 10 Gb/s per wavelength, while 20 Gb/s rates are routinely used in laboratory experiments. Rates as high as 40 Gb/s have been demonstrated in research laboratories, and can be expected to become commercially available early in the next decade.

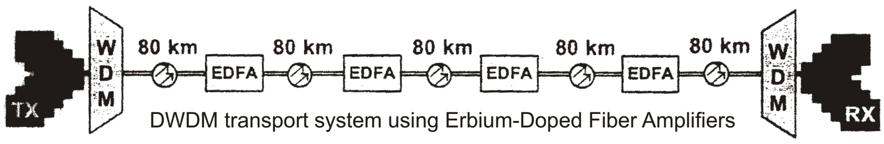
DWDM systems today combine upto 16 wavelengths and transmit them simultaneously over one singlemode optical fiber. Thirty-two wavelength systems will be introduced commercially available early in the next decade.

DWDM systems today combine upto 16 wavelengths and transmit them simultaneously over one singlemode optical fiber. Thirty-two wavelength systems will be introduced commercially soon, and 132 wavelengths have been demosnstrated by researchers. These wavelengths generally lie within the 1530 to 1565 nm wavelength range, which corresponds to the region defined in ITU Recommendation G 655 for nonzero-dispersion fibers designed to support DWDM systems.

A common element in most modern TDM and DWDM systems is the EDFA. These optical amplifiers increase the distance between active network elements, are transparent to signal format and amplify many wavelengths simultaneously. EDFAs have revolutionized the design and operation of high capacity transport systems, and are increasingly being used to replace electronic regenerators.

Signal Impairments in High Capacity Transport Systems

As an optical pulse travels along a fiber, the pulse suffers from several impairments. One occurs when the fiber's chromatic dispersion broadens the pulse to the extent that it can interfere with adjacent pulses. This degradation depends on the fiber's dispersion, the spectral width of the laser source and the bit rate per wavelength being transmitted. For state-of-the art transmitters, the severity of this impairment increases as

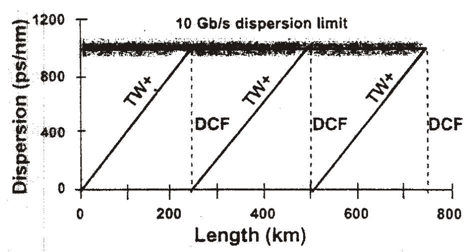


DWDM transport system using Erbium-Doped Fiber Amplifiers the square of the bit rate. So, systems operating at 10 Gb/s per wavelength can tolerate only one-sixteenth the dispersion of systems operating at 2.5 Gb/s.

Another impairment can occur in DWDm systems when the fiber carries pulses at several optical wavelengths simultaneously. Here, wavelengths can mix with one another to produce a nonlinear effect 'four wave mixing (FWM)." FWM produces crosstalk between wavelengths, and can become a dominant limitation to the performance of optically amplified DWDM systems

Reduce Signal Impairments with True Wave Fiber

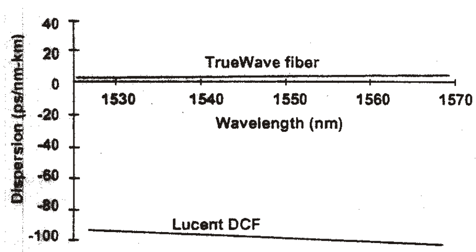
Placed into commercial production in 1993, Lucent's patented and award-winning TrueWave fiber was the first fiber specifically designed to overcome the pulse broadening and FWM impairments that can occur in optically amplified multiple wavelength systems operating at high bit rates. The fiber accomplishes this by using a judicious amount of chromatic dispersion over the EDFA wavelength range. TrueWave fiber's dispersing is low enough to carry high bit rate pulses over long distances without requiring dispersion compensating equipment. At the same time, the fiber's dispersion is high enough to suppress the FWM nonlinerarity by reducing phase matching between the wavelengths used in DWDM systems. TrueWave Fiber has 1.3 to 5.8 ps/nm-km dispersion over the entire 1530 to 1565 nm wavelength range defined by standards bodies for nonzero-dispersion fiber. The fiber can support 10 Gb/s channel rates on each of multiple wavelengths and carry these signals over regenerator distances of about 250 km. Greater distances can be achieved by using either "negatively-chirped" transmitters, which are offered commercially by some transmission equipment manufacturers, or by using "dispersion compensation" to cancel TrueWave's positive dispersion.



The linear dispersion-limited distance for TrueWave fiber at 10 Gb/s per wavelength rates is about 250 km for a zero chirp transmitter.

Dispersion Compensation

The dispersion-limited distance on TrueWave Fiber can be increased beyond 250 km by introducing an appropriate length of Dispersion Compensating Fiber (DCF) into the transmission path. DCF's large negative dispersion compresses the broadened pulse by canceling the positive dispersion in TrueWave Fiber.



Using dispersion compensating fiber (DCF) with TrueWave Fiber.

DCF is generally packaged into dispersion compensating modules that are inserted into the route at one or more optical repeater sites. Although effective at extending the dispersion-limited distance, these modules consume space and introduce optical loss into the path. Offsetting this increased loss may require supplementary amplification equipment. These limitations can be overcome by building dispersion managed routes in which the dispersion signs of the transmission fibres periodically alternate.

Dispersion Management : How does it work ?

Dispersion management is a method whereby routes are constructed with fibres having both positive and negative dispersion. This technique has been used for many years when building submarine fiber optic routes. Now, TrueWave fiber and cable products from Lucent Technologies make the construction of dispersion managed routes practical for terrestrial applications

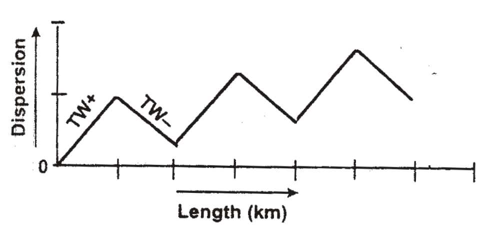
In its most elementary form, a dispersion managed route can be constructed using a transmission fiber with negative dispersion, such as TrueWave-Fiber, followed by a fiber with positive dispersion, such as either TrueWave+ fiber or conventional dispersion-unshifted fiber (USF). The dispersion in each constituent fiber suppressess the local generation of nonlinear effects such as FWM, while the small average dispersion over a regenerator section reduces pulse broadening. If the lengths of each fiber type are properly chosen, the fibers virtually eliminate the need for additional dispersion compensation. The route is "self-compensated".

If using USF for dispersion management, the appropriate length becomes complicated because of the Self Phase Modulation (SPM) nonlinear effect. This effect produces pulse compression in positive dispersion fibers such as TrueWave+ and USF, and reduces the need for negative dispersion fiber. SPM occurs in most high capacity transport systems and leads to a preference for having a net residua positive dispersion within a regenerator section.

To simplify the construction of dispersion managed routes, Lucent Technologies has taken the guess work out of length selection by developing TrueWave Fibers with matched positive and negative dispersions.

TrueWave Positive and Negative Dispersion Fibers

TrueWave+ Fiber (1.3 to5.8 ps/nm-km dispersion) supports multiwavelength DWDM transmission over the full 1530 to 1565 nm wavelength range. TrueWave-Fiber (-5.5 to -1.0 ps/nm-km) is its negative dispersion companion. When used together, the fibers complement one another to minimize pulse broadening and virtually eliminate the need for additional compensating equipment. The smaller absolute magnitude of negative dispersion in TrueWave-Fibre produces an optimum match when accounting for the SPM-induced pulse compression that occurs in TrueWave+ Fiber.



To obtain gte ideal compensation ration, TrueWave+ and _Fibers have slightly different dispersions.

Benefits of Managing Dispersion with TrueWave + and Fibers

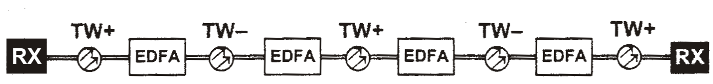
Managing dispersing using TrueWave

Fibers offers several economic benefits

- Dispersion Compensation costs and implementation details are virtually eliminated.
- The entire 1530 to 1565 nm EDFA range is available.
- As will be described soon. TrueWave Balanced Cable gives the additional benefit of allowing the + and fibers to be rearranged in the future to support prospective 20 and 40 Gb/s per wavelength transmission rates.

Building Dispersion Managed Routes Using TrueWave Fibers an Cables

When using TrueWave+ and = Fibers to build dispersion managed routes, the dispersion-limited distance is increased to over 1000 km at 10 Gb/s channel rates. For example, 32 wavelengths, each modulated at 10 Gb/s, have been transmitted over 640 km of alternating positive and negative dispersion TrueWave fibers without requiring any additional compensation.



Dispersion managed route using TrueWave Positive and Negative Dispersion Fibers

Lucent Technologies gives network providers the following two methods to implement dispersion managed routes.

- Two cables types : one cable contains only TrueWave+ Fibers, the other TrueWave Fibers. The two **cable types alternate** at appropriate intervals.
- One cable type : *TypeWave Balanced Casble* contains equal numbers of TrueWave+ and Fibers. **Fiber types within a cable alternate** at appropriate intervals.

In the figure above. TrueWave+ and Fibers alternate from one optical repeater span to the next. If a regenerator section consists of an even number of repeater spans, the dispersion is optimally compensated. For an odd number of repeater spans (as depicted above), there will be a residue of uncompensated dispersion can be ignored because it is sufficiently small as to be insignificant in a 10 Gb/s system.

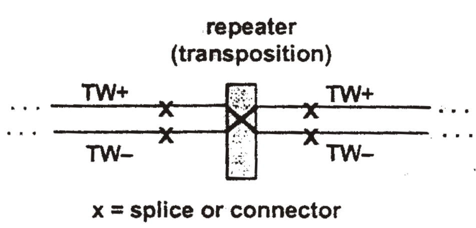
Implementing dispersion managed routes using two cable types entails some administrative and operational precautions. For example, two cable types must be ordered, installed at the proper locations, and retained in inventory for emergency replacement. These inconveniences can be overcome by using TrueWave Balanced Cable.

TrueWave Balanced Cable eliminates some of the obstacles to implementing a dispersion managed route. Because this cable contains an equal number of TrueWave+ and Fibers, only one cable type needs to be ordered, installed and kept in inventory. Furthermore, the proper type of dispersion fiber is always present at every location.

TrueWave Balanced Cable

TrueWave Balanced Cable affords the maximum versatility when contructing dispersion managed routes. This cable contains two types of AccuRibbon® fiber-ribbons in a central core tube cable design. Odd numbered ribbons have TrueWave+ Fibers and even numbered ribbons contain TrueWave - Fibers.

TrueWave Balanced Cable allows routes to be constructed using methods preferred by the network provider. For example, routes can be built precisely the same way as if using two separate cables. In this scenario, all fibers within a given fiber-path between two optical repeater sites are either TrueWave+ or and the transition from one to the other is made at each repeater site. When bit rate systems greater than 10 Gb/s require more precise dispersion tuning in the future, the small residual dispersion resulting from an odd number of repeater spans can be compensated using either conventional techniques, or by transposing the TrueWave+ and Fibers in the center of the repeater spans.



TrueWave + and - Fibers can be configured in alternate at repeater sites

Because routes contructed with TrueWave Balanced Cable contain an equal number of TrueWave+ and Fibers, fibers of both signs are present everywhere along a route. This enables the fibers to be configured to optimize the dispersion management to accommodate enven higher bit rate systems as they become available.

Choose TrueWave Fiber and Cable For Long Term Reliability

TrueWave optical fibers feature D_LUX® Coating for excellent environmental performance and long-term reliability. This dual coating is applied over the cladding to protect the fiber. Each fiber is proof tested to atleast 100 kpsi to ensure that it will survive installtion laods and associated long-term stresses, even under extreme environmental conditions. The excellent geometrical characteristics of the fiber allow low-loss splicing using standard techniques and equipment.

WHAT IS MPLS?

by :
SANJAY KUMAR
DGM/RailTel/Northern Region

MPLS stands for "Multi-Protocol Label Switching" packet-switching VPN technology. After MPLS VPN is used, incoming data packets are assigned a "label" by a "label edge router (LER)". Such labeled packets are forwarded along a "label switch path (LSP)". Along a LSP, each "label switch router (LSR)" forwards a packet based solely on the instructions of the label. At each hop, the LSR strips off the existing label and applies a new label which tells the next hop how to forward the packet. Finally, the LER at the destination system removes the label and delivers the packet to the destined address.

In a MPLS network, LSP is enforced at every hop along the data path such that a secure path is provided across an IP cloud. Specific IP tunnels can be created throughout MPLS network for individual customer, without the need for encryption or end-user applications. LSP paths are designed for their traffic characteristics, as such, they are very similar to ATM path engineering.

LSPs are not restricted to a particular Layer 2 technology but can be flexibly applied to multiple Layer 2 transports such as ATM, Frame Relay or Ethernet. In this way, MPLS enables LSPs to become end-to-end circuits.

What is MPLS-based IP VPN?
It is a IP VPN deploying MPLS technology to mark, classify, and monitor IP packets. At the ingress side of MPLS network, LER examines and determines whether the incoming packets should be labeled. LER classifies incoming IP traffic with MPLS label. The LER converts IP packets into MPLS packets. When the MPLS packets leave the LER, they are examined by LSR for the presence of labels. LSR will then swap labels according to label instructions. At the egress of the network, the LER removes the MPLS header, reconverts MPLS packet into IP packet and forward it to the destined IP network.

What security performance is provided by MPLS IP VPN service?

With MPLS packet labeling method, which is similar to the processing of labels used in Frame Relay and ATM, security level of MPLS IP VPN service is compatible with ATM or FR security level. Users familiar with ATM and FR services can feel comfortable with MPLS security performance.

For security, Do I need to implement IP Sec if I use MPLS-based IP VPN service?

IP Sec is complementary to MPLS VPN service. It is an option to MPLS VPN customers who want to integrate additional security in there network.

What is difference between IP Routing and MPLS VPN Routing ?

In IP routing as an IP packet travels from one router to the next, every router makes it's own decision on where the packet should go .Each Router reads the IP packet header, and then runs a routing algorithm against the destination address to determine the next hop. Every router then chooses its own next hop for the packet based on the packets header and the routing algorithm. Routers will assign each packet into a set of “Forwarding Equivalence Classes (FECs)” They will then map each FEC to a next hop.

With MPLS every packet only has its IP layer header examined once, when it enters the MPLS network. After the initial FEC assignment a 32 bit fixed length label(called MPLS Label Header or Shim Header) is inserted into the packet that contains the assigned FEC then is sent to the next hop router with the label attached. The label is of local significance only. When MPLS routers, which are called label switch routers(LSRs), are provisioned they will set up a table of label to FEC mappings. Each FEC is assigned a next hop. A label distribution protocol(LDP) is used to exchange label information between label switch routers that have a direct connection to each other. The protocol usually rides on top of the routing protocol in use by the use of extensions that have been developed for MPLS. As the packet goes from hop to hop across the MPLS network the network layer header no longer has to be examined by every router. Instead, the label is used to determine the next hop and which new label to use.

The old label is replaced with the new label, and the packet is forwarded to its next hop. With MPLS forwarding, once a packet is assigned FEC subsequent routers do no further network layer header analysis; the labels drive all forwarding decisions

This method of packet forwarding has many advantages over IP layer forwarding. Since a packet is assigned to a FEC when it enters the network, the edge label switch router can use any information about the packet in determining which FEC to use, even if the information is not contained in the IP header. Packets with the same destination arriving on different ports of the router can be assigned to different FECs. Conventional forwarding, on the other hand, can only consider information that travels with the packet in the packet header. A packet that enters the network at a particular router can be labeled differently than the same packet entering the network at a different router, and as a result forwarding decisions that depend on the ingress router can be easily made. This cannot be done with traditional forwarding, since the identity of a packet's ingress router does not travel with the packet.

PRESS RELEASE ON THE OCCASION OF 7TH ANNUAL DAY OF RAILTEL

You may feel great about your mobile service provider who may help you stay connected with your loved ones even at the remotest places across India. However, helping your operator is a network partner that is sweeping India with its 30000 KM and still growing robust fiber network including in the rural India. “Connecting India with Fibers” has been a core rationale of our existence and a constant endeavor has always been to keep you stay connected.

RailTel's product and services have maintained growth momentum set in previous years. The company which was running in accrued losses in the past and was even recommended to BIFR (Board for Industrial and Financial Reconstruction) a couple of years back, has started showing outstanding performances and taking into account the provisional earnings during the first quarter of the year 2007-08, RailTel has wiped out losses completely and is now in profit. Our income during first quarter has been higher by 20% and revenue receipts 44% over that of last year's corresponding period.

RailTel Corporation of India Ltd. has announced launch of various innovative services including passenger amenities at railway stations on the occasion of its foundation day.

New Initiatives:

Reliable Passenger Reservation System (PRS) and Unreserved Ticketing System (UTS), has now became a necessity. To achieve this goal, RailTel is in the process of shifting these vital circuits alongwith those for train operations and control communication on the OFC and MPLS network of RailTel, guaranteeing reliable communication with greater availability. This is expected to bring appreciable cost savings to Indian Railways as well.

RailTel is poised to deliver another first for the high end railway passengers by deploying Wi-Fi hotspots at Railway stations to deliver Internet services to the rail passengers. Initially planned at 50

Railway stations, the service will be delivered on WiMax/Wi-Fi based platform.. In future, it is expected to implement the whole project in phases in over 500 locations across India.

In another major initiative, RailTel has plans to become first NLD network in the country to migrate from conventional network to Next Generation Network (NGN) Technology to enable operators to further cut STD rates and make it more efficient STD (National Long Distance) services to subscribers using RailTel's NLD Network. Initially the network is planned to be rolled out in 14 telecom circles covering 18 cities viz:, Bangalore, Chennai, Mysore, Coimbatore, Secunderabad, Madurai, Mumbai, Pune, Nagpur, Ahmedabad, Chandigarh, Jaipur, Jallandhar, Lucknow, New Delhi, Bhubneshwar, Kolkata and Patna.

In the area of Value Added Services, RailTel is also diversifying in providing VPN services to corporate houses and other important enterprises like banking sector. RailTel is currently networking State Bank of India (SBI)'s branches across 72 cities.

RailTel has already successfully started operation of its cyber cafes branded as “Cyber Express” at 24 stations across India. These are next generation cafes have facilities for web browsing at broadband speed, e-mailing, Internet Gaming, Internet Telephony, Scanning, Printing, Photocopying, faxing and video conferencing all under one roof 24 hours and 365 days.

About RailTel:

RailTel Corporation of India Ltd. (RailTel) is a Government of India undertaking under the Ministry of Railways. The corporation was formed on 26th Sept 2000 with the objective to create nationwide Broadband Telecom & Multimedia Network in all parts of the country, to modernize train control operations and safety systems and to significantly contribute to realization of goals and objectives of National Telecom Policy of 1999.

Since then, RailTel has already built a state of the art STM-16 network using latest SDH Technology for over 30000 Kms thus covering about 3000 stations across the country. RailTel plans to expand its network to over 45000 Kms by 2010 thus creating over 4500 stations (PoPs).

The services offered by RailTel includes National Long Distance, Bandwidth leasing (64 Kbps to 155 Mbps & above), Internet Services, VPN Services (Layer-2 & Layer-3 MPLS, VPLS), Tower Space for Antennae (1000+ towers nationwide), Co-location services & Dark Fiber.

The complete Network is managed by a Centralized Network Management System, located at New Delhi with backup at Secunderabad/Kolkata. RailTel has also built a highly sophisticated nationwide MPLS-IP network across 40 cities to provide a whole range of Internet & MPLS VPN services. RailTel is also building 100 Gbps DWDM network on 16000 RKM and NGN based NLD network covering 45 cities.

RailTel has been able to built a very impressive client list like Bharti, Hutch, Airtel, Idea Cellular, Tata Teleservices, VSNL, Sify, TULIP IT, HCL, IRCTC, IRCON to name a few. With the launch of MPLS-IP network, RailTel is steadily penetrating into the corporate VPN market.

MEMBERSHIP FORM

Name : ________________________________

Present Address : ________________________________

____

____

Working Railways : ________________________________

Designation : ________________________________

Note : Kindly send the same on the following address as the next issue will be sent directly to you.

Institution of Railway Signal & Telecommunication Engineers (India)
Room No. 16, IRCOT Office, Shivaji Bridge,
(Behind Shankar Market),
New Delhi-110 001