

GPS BASED CAB-SIGNALLING FOR INDIAN RAILWAYS – A CONCEPT

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GPS BASED CAB-SIGNALLING

Introduction :

Work on Traditional Land Based Fixed Signalling System.

- Two Aspects (Red & Green),
- Three Aspects (Red, Yellow and Green)
- Four Aspects (Red, Yellow, Double Yellow and Green).

Track side fixed signals

- While Driving train drivers are required to :
- Watch out for signal sighting boards (SSB).
- From the point of SSB concerned signal along with its aspect. shall be visible clearly
- Control his train as per the aspect seen till he reaches / passes the signal.

Merits of fixed signals

- The existing signalling system (Fixed signals) are very robust and time tested.
- It does not require any kind of on-board equipment to work on the railroad.
- All types of trains (freight and passenger) operate with a range of permissible maximum speed, this system serves its purpose quite well and fully safe

Drawbacks of fixed signals

- The train driver has to look for the fixed signals and correctly read the aspect in all weather and day & night.
- Possibilities of reading aspect of any adjacent signal not meant for his route may lead to accidents.
- The signals cannot convey any temporary speed restriction imposed on account of any reasons. For this purpose train crew are advised in writing from the previous station.

CAB SIGNALLING

- All advanced rail roads are having cab-signalling systems based on different concepts of design.
- As of now all the types use some kind or the other type of track mounted / side equipments and on-board train equipments.
E.g. Balises, Coded Track circuits etc.
- Track-side equipments will be vulnerable to miscreant activities and vandalism.

GPS based Cab Signalling

- Global position system (GPS) introduced by US Government
- 24 satellites available round the clock throughout the world.
- With a suitable receiver one can know his location i.e., longitude, latitude and altitude from the ground level when at least 4 satellites are visible by his receiver.
- Initially, it was mainly for its defence applications, common man also could use it with less accuracy of position data.
- Now, US Government has relaxed the restriction of accuracy of position data and now the position data is available with an accuracy of 10 mtrs.

GPS based Cab Signalling

The entire system will comprise of three subsystems

- *Locomotive Subsystem*
- *Station Subsystem*
- *Signal Sub system*

Locomotive Subsystem

- GPS receiver with roof mounted antenna.
- On Board processor.
- Resident data base for all the events like, stations, signals, bridges, level crossings etc.
- Suitable application oriented software.
- A full duplex VHF trans-receiver.

Station Subsystem

All the stations to be equipped with their subsystems comprising

- Power Interlocking System (Existing)
- Station Radio
- Station GPS (As reference GPS)

Signal Sub system

All the fixed signal posts to have their own subsystem comprising

- Colour light signal (Existing)
- full duplex VHF trans-receiver
- GPS receiver (As reference GPS)
- Processor

GPS BASED CAB-SIGNALLING

System Concept

- Loco to find its location continuously
- When approaching station Loco to ask for signal information
- Station sub-system to acknowledge. and response
- Station Sub-system to send sigg information

GPS BASED CAB-SIGNALLING

System Concept

- The GPS receiver on-board the locomotive will remain continuously on to record its current location data.
- The current location data as recorded by the GPS receiver will be fed to the on-board processor.
- The processor will search from its resident database the nearest Railway station
- Calculate its distance from the current location of the locomotive.

CALL REQUEST FROM LOCO

- As the locomotive moves closer(say within 2 km) to the approaching station, it will start sending a call request to the approaching station through its on-board radio.
- On receipt of the call signal from the locomotive, the station subsystem will send acknowledgement signal through its radio equipment installed in the station building.

Dialogue Between Loco & Station

GPS fixed receiver of station will record and create the correction data on a continuous basis and broadcast.

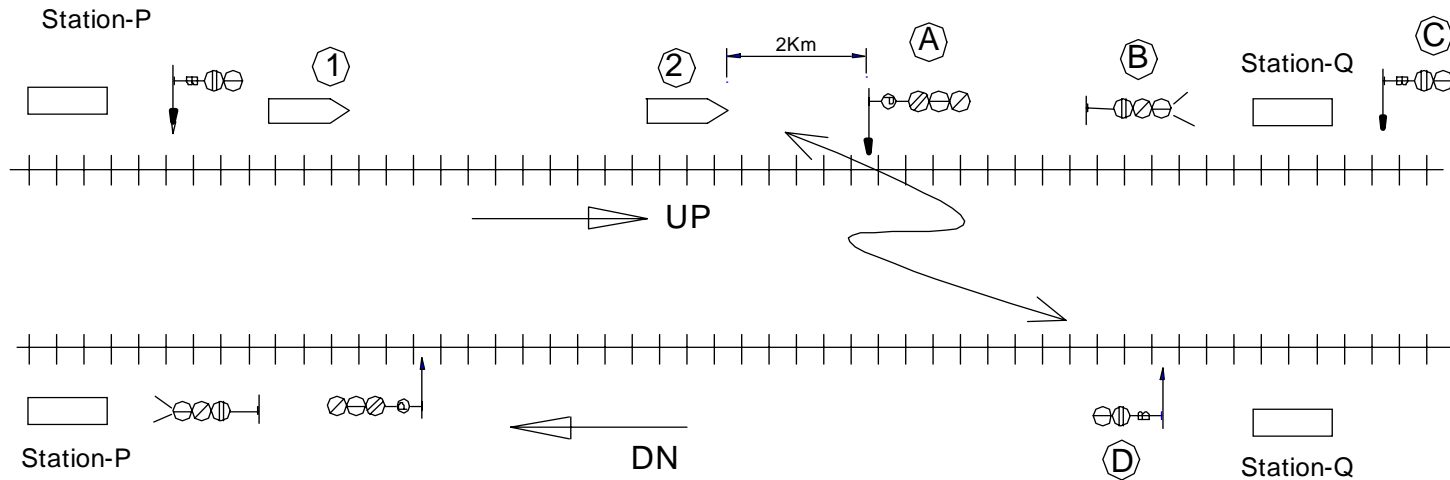
This GPS receiver will form the reference receiver for all the loco mounted GPS receivers of all the approaching trains to work as a differential GPS system (DGPS).

The loco mounted processor will use this correction data and immediately correct its location data with improved accuracy, may be within a meter

Dialogue Between Loco & Station

- The station interlocking system will simultaneously transmit signaling information,
- This information will be received by all the approaching trains of that station .
- Intended train with the help of a proper exchange of protocol will decode the signal aspect, movement authority etc. or any other information and display on the dashboard of its CAB.

Schematic diagram



NOTE:

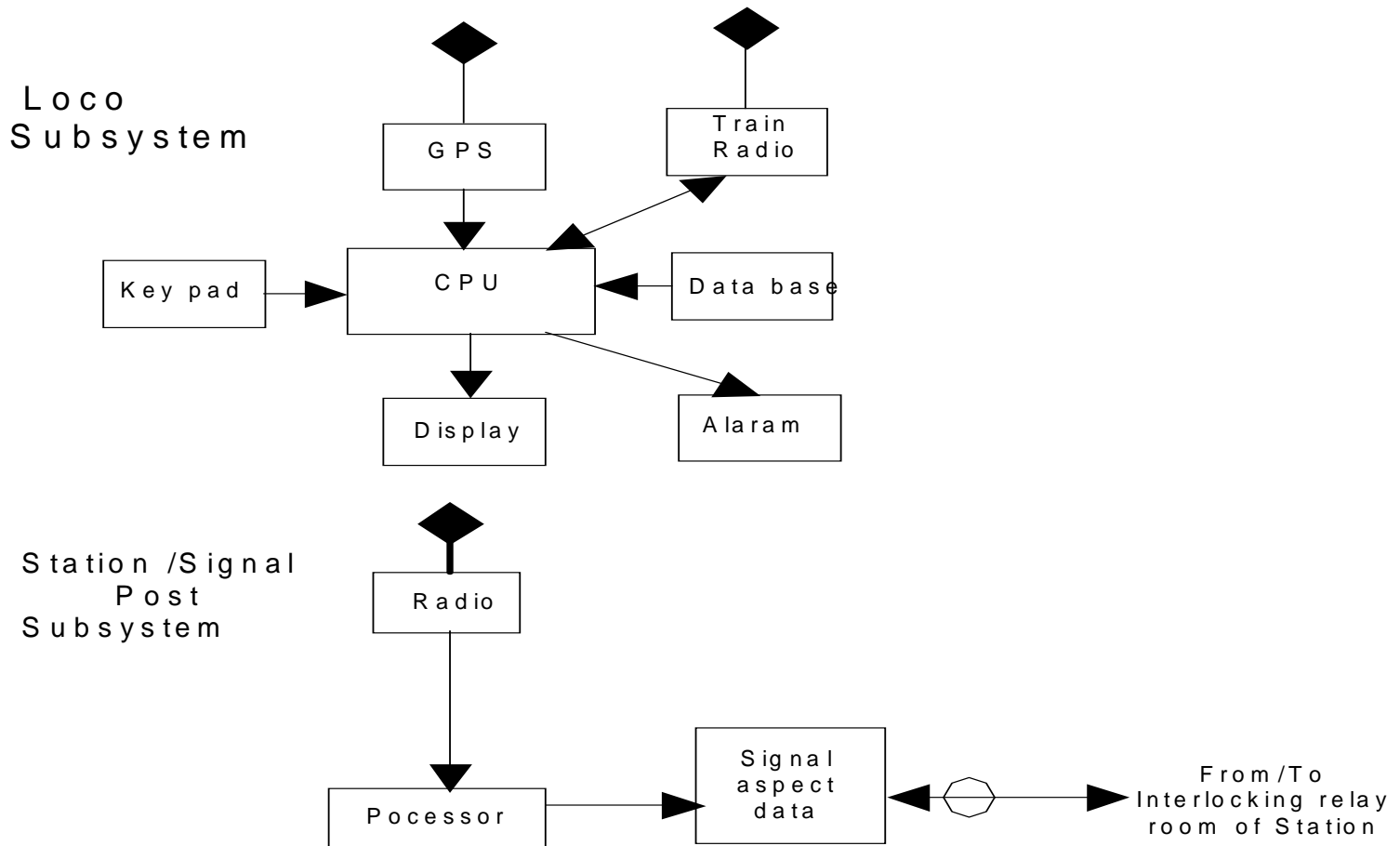
Response from Signal A for train 2 is relevant whereas from signal D is not relevant. This will be filtered by suitable protocol depending on direction of train movement as well as route etc.

LEGEND:

1 and 2 are train locations A, B, C, D, etc. are fixed signals with VHF Transreceivers (Intelligent Signals) P & Q are two stations in the route

Schematic diagram

GPS Based Cab Signalling



Multiple Trains Approaching Any Station

- Each train before sending its call request will ensure that there are no other radios which are simultaneously on.
- Wait for getting the space free from any radio signal.
- After ensuring this, the loco subsystem will actually switch on its radio transmission and it will broadcast its identity and other information and switch off transmission.
- Then, this radio channel can be used by other trains and so on as a shared radio channel.
- A station radio can however broadcast the replies to all trains with proper address code for various trains at a time .

Poor GPS coverage or weak signal

- Trains entering into shadow region like tunnel, dense tree cover, the on-board GPS receiver may temporarily lose its fix.
- This problem can be adequately overcome with the help of a dead reckoning arrangement.
- In this arrangement, the train database can continue to feed the location data to the system taking the input from the on-board conventional Odometer.
- Simultaneously a message can be displayed like etc. Once a fix is re-obtained, the system can again relock and get actual GPS data.

Operation In Automatic Block Signal Territory

- In the automatic signal territory, all the fixed signals will be provided with a Radio-Transreceiver and a small processor in it. As in the non-automatic block section
- Loco GPS based system will continuously calculate its distance from the next signal en-route for it and initiate call request when it comes within a specified distance.
- On receipt of call request the signal post mounted system will respond and transmit its identity and aspect.

Operation In Automatic Block Signal Territory

- The train radio will receive the same and decode it. If found relevant for it, it will display the aspect in the Cab.
- At a regular interval of say 5 km or so a signal post can be provided with a GPS receiver to serve as a reference receiver for broadcasting the correction data for the train GPS(s) when coming in that particular area.
- With this correction data the train mounted system will correct its location with reference to the fixed signals within ± 1 meter and have full control on the movement as decided by the aspects of concerned signals.

Situations of non functioning of the system

- In the event of no response comes from the expected station subsystem or signal subsystem , the system will initiate an alarm for the Driver to indicate that the signal information has not been received.
- Driver is to attempt to see the signal aspect physically as done at present. Similarly, in the event of on-board GPS receiver not functioning,
- Alarm will be raised by system to draw the attention of the Driver. It can also be extended to automatically apply emergency brakes in such events when the Driver fails to acknowledge the alarm and or take necessary action in time.

Other facilities

- The location data about other permanent type of track features or events namely, gradient, temporary speed restrictions, level crossing gates etc can be permanently stored in the data base of loco sub-systems.
- From the location data generated by GPS receiver to be continuously used for calculating the distance of those fixed features.
- These features can be displayed inside the loco, either by graphical symbols and or through pre-recorded voice.

Other facilities

- This will help the Driver to know before hand that which are the spots he is approaching and at what moment of time.
- This can however be extended to take decisions of running speed as per the data stored for the respective section of the route.
- It will be possible to keep a continuous log of the events based on what speed, what time, automatically by on-board system.

Conclusion

Initially, this concept may be used for an aid of the Driver.

After a thorough trial, the system can be used for regular cab signalling and other signalling applications.

Thank you