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रेल मंत्रालय

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

आप्टिमाइज्ड लोको प्रचालन हेतु निर्देशन के लिए विशिष्टि

**Specification of Guidance for Optimized Loco Driving
(GOLD)**

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SPECIFICATION FOR GUIDANCE FOR OPTIMIZED LOCOMOTIVE DRIVING (GOLD)

1.0 Objective: The objective of this specification is to lay down the functional and hardware requirements of an in-cab advice system that helps Loco Pilots of both freight & coaching trains to save fuel and stay on time i.e. keep to the sectional running times as per the intended schedule. Part A of this specification defines the functional requirements and part B defines the broad hardware requirements.

2.0 System description:

2.1 Brief Description of the System: GOLD shall be an in-cab advice system that shall help Loco Pilots of both freight & coaching trains to save fuel and stay on time i.e. keep to the sectional running times as per the intended schedule. GOLD shall use optimal control theory to determine speed profiles that minimize fuel consumption subject to completing the journey within the specified time. The recommended speed profile shall be displayed on a screen in the cab of the locomotive along with additional advice about track topography and train location that will assist the Loco Pilot to follow an energy-efficient speed profile and stay on time. The system shall determine current location and speed from an on-board GPS unit and continually update the displayed advice during the journey, thereby ensuring that the advice is always optimized for the remaining journey based on actual progress of the train from the recommended speed profile. Thus the in-cab display shall always provide an optimal speed profile from the current position to the next target location. This technology shall ensure that best driving practice becomes the norm and hence consistently reduces fuel costs.

2.2 Aim of GOLD: The aim of GOLD shall not be to override Loco Pilots, but to provide them with information that will help them drive more efficiently. GOLD may not take into account signals or train-handling requirements. When it is not appropriate to follow the ideal speed profile because of track conditions, restrictive speed signals or unexpected speed restrictions, the Loco Pilot shall simply ignore the advice until it is appropriate to follow the displayed speed profile.

2.3 Energy Savings: Energy savings shall result from the system's ability to anticipate the upcoming topography i.e. increasing/decreasing gradients, horizontal curves and speed limits while using the known performance characteristics of the train such as tractive effort, weight, length, rolling resistance etc to calculate and communicate the optimal driving profiles for any given journey.

2.4 Loco Pilot: At the beginning of a trip, the Loco Pilot shall specify information that is used to calculate ideal speed profiles, including:

- The number and types of locomotives
- The type of train (used to determine which speed restrictions apply)
- The number of and type of wagons / coaches.
- The mass of the train
- The maximum permissible speed of the train
- The route and

- Fuel balance at the start and end of journey and any additions in between for diesel locos.

2.5 Data input: The above information may be selected from menus on the touch screen. Alternatively, this information may be automatically downloaded from a central server. Temporary speed restrictions shall be automatically uploaded to the on board advice unit (OAU) from a central server over a wireless data network.

2.5.1 The system shall be capable of computing and displaying several optimal profiles, each of these optimal profiles shall have a different arrival time. The fastest profile shall have the earliest arrival time, but shall use the most energy to complete the journey. Each of the subsequent profiles shall use less energy than its predecessor, but shall take more time. Destinations are key locations along a journey where the train has a specified arrival time.

2.5.2 Destinations can be crossing loops where the train will pass or overtake another train, key junctions, crew change locations, or terminals. Each time the Loco Pilot selects a new destination, *GOLD system shall have the facility* to automatically adjust the optimal driving strategy to ensure that the train arrives at its destination at the required time with minimum use of energy by computing optimal driving profiles from the current location to the destination.

2.6 Speed Profiles:

GOLD speed profiles shall save fuel by:

- Cruising at speeds less than the speed limit, if time allows;
- Coasting; and
- Reducing the amount of braking, particularly at high speeds.

2.7 Display : During a journey, Loco Pilots shall glance at the display to check the progress of the journey, and to see what control changes may be approaching. At the end of each journey, *GOLD* shall upload a journey log to a central server using wireless communications. The figure below shows a typical advice graph that shall be required from a *GOLD* log for a specific journey. This is an indicative display screen and shall be finalized after discussion. However, all successful tenderers shall have to design a common screen so as to facilitate easy understanding by the locomotive drivers.

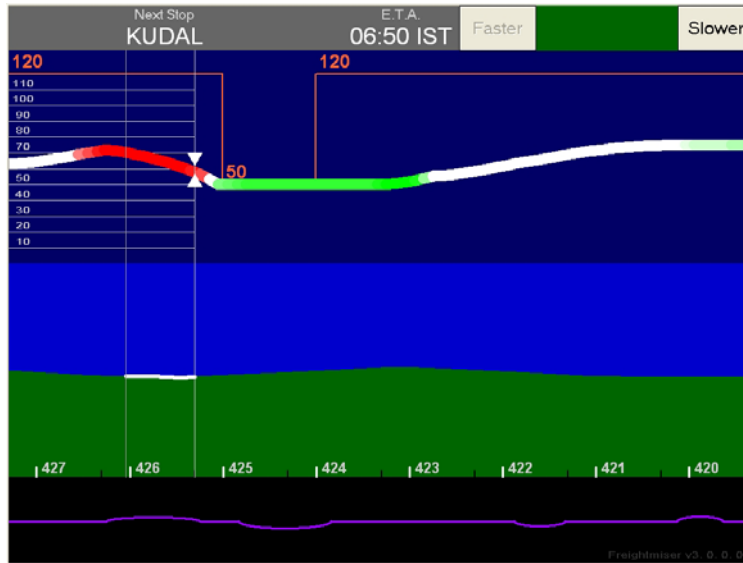


Figure 1 – GOLD Main Display (Indicative)

The main GOLD display as shown on the screen at Figure 1 above shall be divided into three areas:

- 2.7.1 **Route Information:** The bottom half of the display shall show track elevation, track curvature, and trackside features such as level crossings, signals, kilometer posts and crossing loops, for 6 km in front of the cab and 2 km behind the cab. The location of the train shall be indicated by the white line superimposed on the elevation profile. The vertical white lines shall indicate the front and rear of the train. Loco Pilots shall find the route information useful because it shall show the location of the front and rear of the train relative to hills, curves and speed restrictions, and because it shall provide confirmation of the train's location.
- 2.7.2 **Ideal Speed Profile:** The part of the display immediately above the route information shall show the ideal speed profile calculated by GOLD. The height of the thick line shall indicate the ideal speed. The color of the line shall indicate how much power is required to follow the ideal speed profile: green shall be full power, white coasting, and red braking. The thin orange line above the ideal speed profile shall indicate the track speed limit, including any temporary speed restrictions. The two white triangles shall indicate the current speed of the train, as measured by the GPS unit. Whenever possible, the Loco Pilot should drive such that the two triangles straddle the ideal speed profile.
- 2.7.3 **Destination:** The top strip of the display shall show the current destination and the estimated time of arrival. The various speed profiles generated shall be shown with colored bar to indicate which of the possible profiles is being

followed, from the least efficient speed profile to the most efficient speed profile. It shall be possible for the locomotive driver to select the destination of his journey on real time basis.

2.8 ON BOARD SYSTEM ARCHITECTURE

2.8.1 The GOLD System

The complete GOLD unit shall be a standalone system with minimal integration with the loco. It shall draw power from the loco auxiliary power supply at 72 volts. The base system shall consist of loco power supply providing power to a touch screen and a separate processor including communications via GPRS/GSM/WLAN and an integrated GPS receiver.

2.9 GOLD SYSTEM SCHEMATIC (CONCEPTUAL)

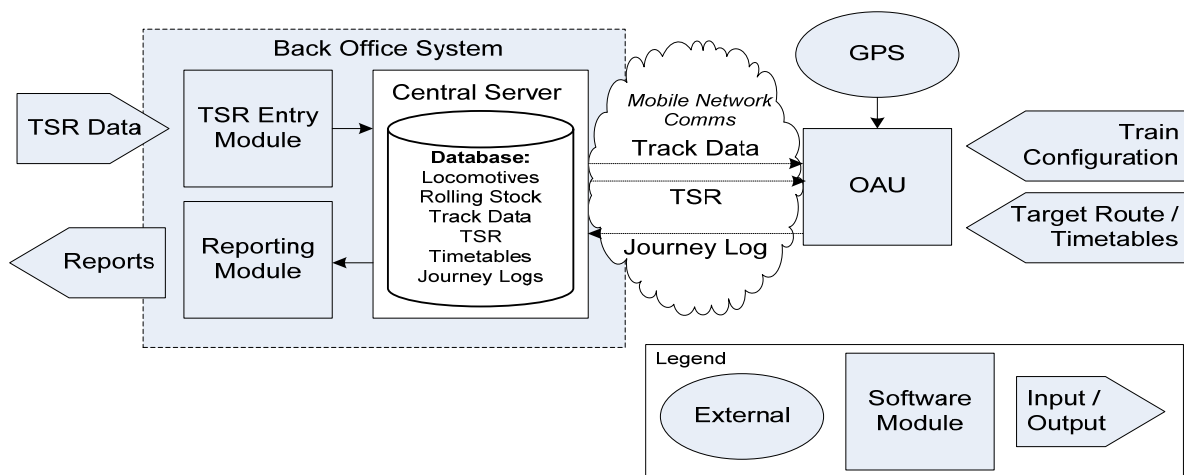


Figure 2: GOLD System Schematic (conceptual)

3.0 Scope of supply: The system shall have software modules and hardware equipment. The software portion is discussed in part 'A' of the specification while the hardware portion is discussed in part 'B'. The purchaser may procure both software and hardware modules against this specification or may choose to procure them separately against part 'A' and part 'B'.

3.1 Software modules: It is intended to procure the software as an **enterprise license** so as to enable IR to implement GOLD on any numbers of its locomotives as required without having to pay further license charges. The hardware shall, however, be procured according to the implementation plan for GOLD. An 'enterprise license' is typically defined as under;
"A software site license that is issued to a large company. It typically allows unlimited use of the program throughout the organization, although there may be restrictions and limitations. It always foregoes the need to register the software each time it is installed on another computer; however, there might be a master password that is required to activate each copy."

3.1.1 Onboard Advice Unit

The software module shall be presented via the onboard advice unit (OAU). The software module for driving optimization shall reside on the onboard processing unit (OBPU), that shall in turn be located on the locomotive. It shall download the required train, track and

timetable data from the land based server (via a suitable mobile network) and provide driving profiles to the driver for optimum energy consumption without compromising on arrival times. The driver shall interact with this module via the TFT/LCD touch screen (OAU). As and when the new Loco Pilot logs on to the OAU, the previous journey log shall be uploaded to the central server via the mobile network.

3.1.2 Database

This shall be a relational database management system, such as Microsoft SQL Server or Oracle database. This database shall hold the track data, TSRs/ESRs, timetable data and journey logs.

3.1.2.1 TSR Entry Module

This shall be a browser-based application, which shall allow users to enter the TSR data (data such as speed restrictions, that are liable to change frequently) into GOLD database. The TSR data shall be converted to GOLD format and saved to the database. This TSR data shall then be uploaded onto the Onboard Advice Unit at the start of each journey. As a customization, the TSR entry process shall be automated if the required data is available in electronic format. This software tool shall reside in the land-based data feeding units located at various points.

3.1.2.2 Reporting Tool

This tool shall allow users to access the journey logs and generate / view reports of the same from the central server. This tool shall reside in the land based nodes that are used for analysis of journey data.

3.1.2.3 Timetable Management

- GOLD shall require train, track and timetable data, including Temporary Speed restrictions (TSRs), and the current journey information to provide advice to the driver for energy savings. In order to keep the track data up-to-date, GOLD shall check and upload track data, timetable data and the TSR data at the start of each journey.
- Maintaining the Timetable data for the GOLD system may be a significant task due to the large volume of information. Similarly, maintaining the TSR data on a daily basis, which changes from one day to the next, may also be a complex and time-consuming activity especially when there may be several track routes and when they may come from multiple sources in various forms. As such, the timetable data and the TSR data shall be uploaded as part of the GOLD system, using an automated and/or upload process. In addition, the system shall allow users to view and edit this information as and when required, before being used by the GOLD onboard Advice Units (OAUs) that shall be installed on trains.
- Timetable Optimization Module: This module shall be used for optimizing timetables that are available in the system. If current location of trains are available, then this module shall be used to optimize timetables in real-time during major delays disruptions (e.g. derailments, breaches etc) and optimized timetable information shall be loaded onto the OAU. *This module is optional and may be priced separately.*

3.1.2.4 Timetable Architecture Overview (Conceptual)

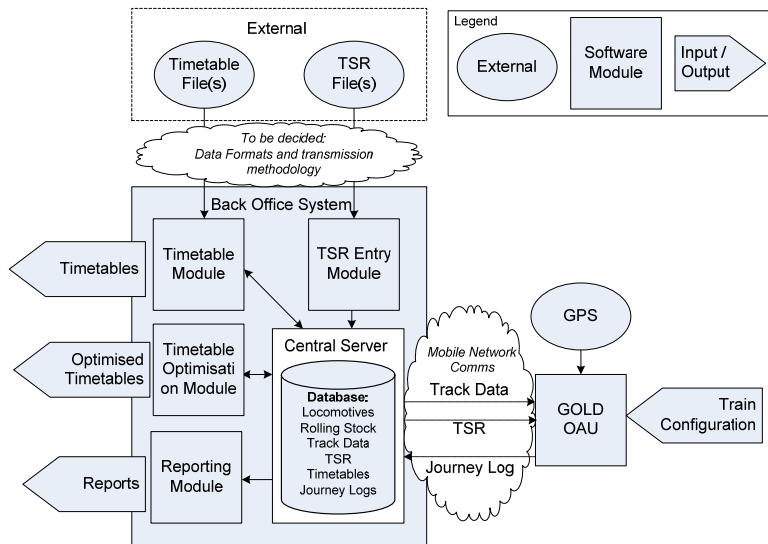


Figure 3: GOLD Timetable Architecture Overview (conceptual overview)

3.2 Data requirement: The GOLD system shall need basic train, timetable information and track data based upon which the optimum profiles shall be generated. Following data is generally available and shall be made available by IR. In case some other information is needed, the tenderer shall spell it out clearly in their offer and the same shall be provided subject to availability with the purchaser.

3.2.1 Timetable Data Requirements

- Journey Header Data
 - Train ID or Head Code: unique identification of each journey within the timetable
 - Days of Operation: days of week on which the current journey is operated
 - Train and consist information; including type of rolling stock, locomotives etc.
 - Effective dates: start/end dates of the journey or the timetable
- Journey Details
 - Locations traversed by the current journey: this is the order of locations traversed by the current journey. This includes all stations and junctions on the current rail network traversed by the journey.
 - Stopping mode at each location traversed by the journey, such as passing, dwelling, etc.
 - Arrival and departure times at each location traversed by the journey.

3.2.2 TSR Data

- **TSR Start/End Location**

The start and end locations shall be specified in terms of route kilometers. In this case, the following details of the start and end locations shall be made available:

- Start Track Segment
- Start Km
- End Track Segment
- End Km

- **TSR Dates**

Start and end dates of the TSRs shall be made available

- **TSR Speeds**

TSR speeds for all types of trains shall be made available separately, e.g.: if the TSR speeds differ between passenger trains and other, then each TSR speed shall be available for each category.

- **Directionality**

Whether the TSR is applicable for the direction Up, Down or Both

- **TSR Description (optional)**

Other TSR details, such as Speed Restriction Number and Speed Restriction Year, may be made available for record keeping purposes.

3.3 APPLICATION DESIGN

The Successful Software Developer shall provide an Advisory System which, once installed and configured, shall provide real-time advice to the Loco Pilot in the cab (power/hold/coast) that, when followed, shall allow progress of the train to be regulated to give the lowest calculated energy consumption whilst achieving compliance with the timetable. This advice shall have to be based on profiles for each route, but also calculated in real-time based on current speed/location. Logged data of driving behavior shall be sent to a central server for analysis and reporting. The system shall:

- Upload base data to the central server.
- Upload base data from the central server to the onboard processor
- Upload display modifications from the central server to the onboard processor
- Display real-time advice to Loco Pilots based on profile recommendations and on their current locations / speed and next expected stop e.g. when to start coasting/ braking etc.
- Log the driving behavior for each journey.
- Automatically download journey logs from the onboard processor to the central server.
- Allow for analysis and reporting of that data.
- Store and Manage timetables for passenger services and train running information for freight services and be capable of editing that information and uploading changes to the onboard processor

- Manage temporary speed limits and emergency speed limits and upload these to the on board processor

3.4 Software Solution Being Offered

Bidders shall specify technologies proposed for at least the following:

3.4.1 Solution Design Proposed

Describe the existing products/modules that will be deployed for this project and their inter-relationships (diagrams maybe attached if necessary).

3.4.2 Change Management Methodology Proposed

- Describe the problem escalation mechanism with name, designation and contact details at each level up to the level of CEO
- Proposed quality plan setting out methods and agencies controlling quality at different stages of the project and a proposed inspection schedule shall be described
- Commitment to provide warranty support as per the standard IRS conditions (24 months from date of fitment or 30 months from date of supply) at no additional charge after acceptance of the system by the competent IR authority.
- Commitment to provide post-warranty support for at least five years (An affirmative response means a commitment to support the application if so desired by the IR, at charges to be determined before expiry of the warranty period or at the time of entering into the maintenance contract)
- Confirmation of ownership of source code (An affirmative response confirms that all source code customized / developed under this contract shall be the property of IR as specified in this document)

3.4.3 SPECIFICATION REQUIREMENTS AND GAP ANALYSIS

A document on Gap Analysis of the software modules being offered for customization as compared to the system requirements provided in this document. It shall specify the extent to which the system requirements are:

- Fulfilled by existing & proven software modules of the bidder
- Needs customization (details shall be furnished)
- Fresh development (bidder shall substantiate his capability to develop by way of past proven developmental effort relating to railway fuel optimization application)

This document shall also describe the specific modules that are part of the bidder's Software package that shall have to be deployed to meet the requirements of this specification

3.5 Hardware modules: The hardware is detailed in part 'B' of the specification and the procurement quantity shall be decided based upon the implementation plan of the railways. These shall essentially comprise the following items:

3.5.1 OAU: On board advice unit. This shall be an industrial grade ruggedized touch screen display that shall indicate driving profiles and other information to the driver.

3.5.2 OBPU: Onboard processing unit. This shall be a state of the art 32 bit microprocessor

capable of processing and handling the required information. The OAU shall be interfaced with the OBPU

3.5.3 **Power Supply:** Display Systems and OBPS shall draw power from the locomotive auxiliary power that is at 72 volts/DC.

3.5.4 **Land based central server:** Detailed Hardware equipment for the central database server (to be installed & commissioned at a location identified by IR) shall be clearly specified by the bidder as part of the project. The bidder shall suggest the architecture for the proposed solution. The architecture shall be designed to meet with the technical specifications and the functional user requirements. This architecture shall be reviewed by IR for its acceptability and only after that the successful bidder shall proceed with server procurement if required.

3.5.5 **Data entry nodes:** Nodes for uploading / updating the TSR and Track Data shall be located at the various control units of IR.

3.5.6 **Data up linking:** Mobile Network connections for the OBPU's and the land based Data Entry nodes shall be provided by the successful bidder for a period of upto 12 months from the implementation of GOLD being completed at a particular diesel shed. This shall be subject to a maximum period of 24 months from commencement of installation at a particular shed.

3.5.7 **Onboard antenna:** This shall be needed for linking the OBPU to the land based servers via the mobile network. The system shall be capable of communicating through GSM / CDMA / WLAN networks depending upon availability at the location.

3.5.8 **Onboard aerial:** This shall be needed for catching the GPS signal to make the GOLD system aware of the locomotive location

4.0 GENERAL REQUIREMENTS

- Failure of GOLD system shall not compromise, nor in any way affect the operational safety of the train. GOLD shall be universally suitable for all types of sections of Indian Railways like single line, double line, twin single line, multiple lines etc.
- Gold shall be suitable for both freight and coaching trains. It shall have suitable train planning software so as to upload coaching train timetable on central server to enable the system to save fuel while maintaining punctuality.
- GOLD shall be suitable for all types of electric and diesel locomotives.
- GOLD shall be capable of working in all types of electrified as well as non-electrified territories.
- GOLD shall be suitable for all train speeds, loads and length.
- Journey logs of each GOLD unit shall be stored for a period of 45 days on the central server. The information stored on the central server shall be available on a controlled access basis to relevant supervisory/managerial personnel to review the performance of individual Loco Pilots/sections etc. It shall be possible to download all the events to a PC/ Laptop. Analysis & diagnostic software shall be provided to analyze the events on PC/ Laptop. The relevant supervisory/managerial personnel

shall also be able to print reports of these journey logs in user friendly and easily readable format.

- It shall work on the locomotive power of 72 Volt DC
- The System shall start up automatically when the locomotive power is on and shall have security access via Loco Pilot ID.
- The system shall have a comprehensive server side data base to manage track and train data as well as timetable data, train running data and reporting
- The system shall be configurable to the display advice if the train deviates from the expected speed profile, or detects a GPS drift away from the track centerline.

5.0 Changes and enhancements in the Scope of Work

If during the execution of the project it is found that IR wants changes in the Scope of Work, then the Successful bidder and IR may renegotiate the contract upon mutual agreement in writing subject to the tender not getting vitiated. In the absence of a mutual agreement, the scope of the work shall be as detailed in this document.

6.0 Validation of the offer:

1. The extent of fuel savings that can be effected on a particular route/ train depends also upon the sectional profile i.e., gradients, curvatures, speed restrictions etc. Therefore this document is not defining any threshold or qualifying limits of fuel savings in terms of a predefined value.
2. Before selecting a system it shall be tested in actual operation and the average fuel consumption/savings over several runs shall be evaluated against established values of a proven system (if any).
3. Bidder(s) whose offers are found to be technically suitable shall be called upon to make available their product (at their own cost) for trials on nominated routes/ trains as decided by the purchaser.
4. The exact modalities for trial and the trial scheme shall be finalized by IR in consultation with the short listed Bidder(s) prior to commencement of such trials.
5. In case there is more than one shortlisted Bidder for such trials, the trials shall be conducted on the same route, locomotive & type of trains for all the bidders. In such a case comparative evaluation shall be carried out for the shortlisted systems.
6. The decision of IR in regard to the outcome of these trials shall be final.

7.0. Qualifying Criteria

1. The bidder shall offer a system that has been proven in operations in any major passenger/freight railway (of at least 5000 route kms) and must have been installed on at least 100 high HP locomotives (greater than 3000 HP). The system must have been in successful (with documented fuel savings) operations for at least 3 years. The system shall be capable of being used in both passenger and freight trains.
2. The bidder shall produce documentary evidence of meeting the above specified criteria and also of fuel savings achieved through implementation of the system, in the past.
3. The bidder shall have expertise / past experience (of at least 3 years) of having executed time table optimization software for train sets (passenger operations) and / or

freight train operations. *This clause shall be applicable only if railways purchase the optional module of Time table optimization (vide para 3.1.2.3)*

8.0 DOCUMENTATION

Manuals & guides: Successful bidder shall provide manuals and guides (number to be agreed at the appropriate stage) both in soft and hard copy format covering the following aspects:

- Driver setup and operation
- Diagnostics/maintenance of software
- Alteration and addition of any information
- Administrator function and access
- Report generation
 - Drivers operating instructions and trouble shooting handbook
 - Training manual for Loco Inspector's i.e. Trainers
 - Training manual for Loco Pilots
 - Installation manual

9.0 SCOPE FOR SOFTWARE ANNUAL TECHNICAL SUPPORT (ATS)

9.1 System Software

For the system software, installation, configuration & ATS charges for first year shall form part of the Quotation. Annual Technical Support prices for the second through to the sixth year to be quoted separately.

9.2 Application Software Annual Technical Support (ATS)

For the first year after commissioning, the software shall be under the developmental support and warranty and the ATS shall commence thereafter. The scope of ATS is as given below:

1. Delivery, installation, configuration, tuning and performance of the System and Application Software shall be the responsibility of the Vendor.
2. Production and development environment shall be set up by successful bidder for all releases and testing purposes.
3. The bidder shall enclose documentary evidence along with escalation matrix that they have the necessary organizational infrastructure to provide support to IR for maintaining system health and fine-tuning system performance.
4. For ATS, payment shall be released after satisfactory maintenance provided by the vendor.
5. ATS shall cover free upgrades as and when due.

10.0 TRAINING

10.1 Scope of Training

- The Software Developer shall arrange free of cost training to the personnel of Indian

Railways for 500 man days in India or 250 man days abroad (in case the system is procured from overseas sources) to make them proficient in the operation of GOLD system, including, but not limited to, upkeep of database, generation of reports, trouble shooting, debugging of the system, providing adequate guidance to enable them to train their subordinate staff in these functions.

- Training to nominated end users and core team members shall be organized in suitable batches of appropriate duration in consultation with Indian Railways.
- Training material and documentation for each course shall be provided to each member.
- Details of the training proposed to be provided shall be detailed & agreed upon by the successful bidder within 45 days of the contract being signed.

11.0 SOFTWARE

11.1 Language

Software shall preferably be in a higher-level language. Software interface to the user (Uploading, Calibration, Configuring, Data pack, Downloading, Decoding etc.) shall be menu driven and user friendly.

11.2 Licensing Requirements

- IR requires the capability to deploy the software solution amongst its fleet of diesel locomotives for various applications to meet IR's operational requirements
- Bidders shall be required to enter into an Enterprise License agreement with IR, which shall enable IR to execute a single master license agreement whereby any user within IR would be able to activate the software as per the agreed terms and conditions.
- Under the enterprise license IR may use and install the Software on unlimited number of its Locomotives within India. The successful bidder shall provide with an enterprise license key to IR for activation of the individual installations.

11.3 Ownership of customizations/developments

- For any software developed/customized for IR under this project, complete source code including the enhancements developed as a part of this project in partnership with IR shall be handed over to IR along with intermediate code and executable code.
- The rights for any intellectual property created, as part of this project shall be shared equally between the vendor and IR. Though in the normal course, IR may not modify the software without notifying the vendor, it reserves the right to make any change in the software at any stage without assigning any reason. The above applies to all software developed or customized exclusively for IR. It however does not include any standard software product loaded into the system.
- All documentation shall similarly become the property of IR as soon as it is handed over for scrutiny or acceptance. Such documentation shall include application software plans, drawings, specification designs, reports, user manuals, system documents etc.
- Notwithstanding any of the above, the Successful bidder shall indemnify IR against any damages or liabilities arising out of infringement of any intellectual property right whatsoever as a result of development, customization, installation or deployment of the software on any hardware belonging to IR, at any stage of the project.

12.0 ROLE OF RAILWAY PERSONNEL

IR shall have the option of associating its personnel with each stage of the work. The Successful bidder shall provide these personnel with all the necessary information and facilities to carry out their functions. But the fact that IR personnel are associated with the Successful bidder's personnel in the contracted work shall not in any way reduce the Successful bidder's responsibilities under this contract. Final responsibility to satisfy Railways of the satisfactory completion of the work shall rest with the Successful bidder.

13.0 TIME TABLES

Working time tables for coaching trains shall be provided by the purchaser. These shall be in electronic format. The bidder shall have train planning software to enable the timetable data to be stored on a central server and uploaded to each train's OBPU. The offered software shall be capable of facilitating easy input of temporary/special train timetables as and when required. The offered system shall be able to adhere to the published timetable & at the same time save energy.

The system offered shall be capable of handling real time changes in the timetable.

14.0 ROUTE DATA AND GPS MAPPING

Route data e.g. line of route, stopping points, permanent speed restrictions, elevation, gradients, curvature etc shall be provided by the purchaser. Based on this the successful bidder shall have to carry out the GPS route mapping of the sections taken up for GOLD implementation. For the routes mapped by the successful bidder the GPS co-ordinates shall be within an accuracy of +/- 10m. The accuracy of the mapping shall have to be demonstrated by the successful bidder to IR.

Section B

1.0 This section deals with the hardware requirements of GOLD system. The hardware may be procured separately through a separate tender or may be clubbed with the tender of GOLD software (as per part A) by the purchaser. The hardware shall be procured directly from the manufacturers who shall have adequate facilities to assemble the system. In case the procurement is clubbed with the software, the tenderers shall have to arrange offer from manufacturers/assemblers in case they themselves are not the manufacturer/assembler.

1.1 It is intended to procure the software as an **enterprise license** so as to enable IR to implement GOLD on a pre-defined nos. of locomotives as required without having to pay further license charges. The hardware may, however, be procured in a phased manner according to the implementation plan for GOLD.

1.2 The GOLD unit shall be a standalone system with minimal integration with the loco. It shall draw power from the loco auxiliary power supply at 72 volts. The system shall be modular, providing a fully upgradeable system. The base system shall consist of loco power supply, providing power to a touch screen, and separate processor including communications via mobile network and an integrated GPS receiver. The tenderers shall make themselves acquainted with the locomotives on which the system is intended to be fitted. They shall submit the outline drawings of the offered equipments that shall be evaluated by Railway for suitability of fitment on the locomotive. Alterations if any shall have to be carried out by the shortlisted bidders.

1.3 The photographs given below are only indicative and the actual equipment offered may differ.



2.0 The hardware essentially shall consist of the following items:

2.1 OBPU - On-Board Processing Unit

- This shall be needed for non-microprocessor locomotives.
- The On Board Processing Unit shall load the optimal profile data in the Display (OAU).
- The OBPU shall have a state of the art 32 bit processor with high computational power to process all the data analysis requirements
- The OBPU shall continuously monitor the current speed profile and estimate the delay or advancement of the time taken by the current profile.
- The OBPU shall auto-reload or provide a new optimal profile in case of a delay/advancement in the schedule.
- The OBPU shall be capable to simulate a new optimized profile on board as and when required.
- The OBPU shall be mounted at a suitable location on the locomotive and shall be connected to Oahu's
- The OBPU shall update speed advice via GPS receiver using standard NEMA protocols

2.2 OAU- on-board advice unit.

The contents shall include:

- 2 nos. industrial gradeLCD/TFT touch screens of maximum 13" size, capable of day/night visibility.
- Take input from the OBPU.
- Be of rugged design and suitable for railway applications.

- Be the key interface between the GOLD system and the Loco pilot.
- Show the optimal speed profile and current speed
- Show the train position including the start and the end of the train
- show the optimal speed profile as well as the control mode power, speed holding, coasting and braking (slow) and shall do this on a colored graph that allows loco pilot to make the decision about throttle notch and braking.
- give a clear indication for coasting, braking and powering
- show the current time, target journey time (ETA).
- indicate gradients, speed limits including TSR's and curves.
- have a provision to select the train route via the Train ID.
- Be mounted on the control desks of the locomotive in both long & short hood configuration leading position.
- have appropriate background and dimming features so as not to have glaring effect for the loco pilot, both in the night & day.
- Be touch sensitive. The Loco Pilot may touch the destination indicator to bring up a menu of alternative destinations. The Loco Pilot may also use the "Earlier" and "Later" touch-screen buttons to select a faster and less efficient profile with an earlier arrival time or a slower and more efficient speed profile with a later arrival time. The estimated time of arrival shall be updated accordingly.
- have a delay attribution screen that shall be automatically invoked in the event of an unscheduled stop and shall allow the loco pilot to enter the cause of the delay from a list and these delays shall be logged.
- At the end of the trip, the loco pilot shall be able to enter fuel information and shall be able to view a report on the journey and energy efficiency.
- The final screen display shall be finalized in consultation with the successful bidder.

2.3 Power Supply

- Display Systems and OBPS shall work with the locomotive auxiliary power that is at 70+-2 volts/DC.

2.4 GPS(optional): in case the locomotive is not already equipped with a GPS module, a separate GPS module shall have to installed with the following specifications;

1.1.1 The unit shall have an in built GPS Receiver having the following technical specifications:

- i. L1 Frequency C/A Code with 12 (or higher) independent Tracking Module (Channels).
- ii. It shall support NMEA-0183 Protocol.
- iii. Tracking Sensitivity shall be better than -150 dBm.
- iv. Autonomous Positional Accuracy shall be better than 10 Meter.

- v. Maximum Altitude is 18,000 Meter and Maximum Speed is 515 Meter/Second.
 - vi. 1Hz Update Time
 - vii. Reacquisition time < 250 Seconds
 - viii. Cold Start better than 45 Seconds
 - ix. Warm Start shall be better than 38 Seconds.
 - x. Hot start better that 5 Seconds
 - xi. Antenna Short Circuit Protection
 - xii. Built-in Antenna supervisory circuit for determination of active antenna open or short state
 - xiii. Built-in non volatile RTC with battery backup option
- 1.1.2 GPS antenna along with its cable of sufficient length shall be provided with each unit. The antenna shall be portable & shall have magnetic base which can be fixed on loco body outside. The magnetic base shall be strong enough to keep the antenna fixing intact even under vibrations experienced by a running locomotive. The length of the antenna cable shall be sufficient to connect between antenna & GOLD unit kept on the cab counter.
- 1.1.3 System shall determine the correctness & quality of the GPS signal received and in case quality of signal is not considered adequate to correctly identify its location, the same shall be indicated on the LCD display.

2.5 Land based Server

2.5.1 Details of Hardware equipment for the central database server (to be installed & commissioned at a location identified by IR) shall be clearly specified by the successful bidder as part of the project. The bidder shall suggest the architecture for the proposed solution. The architecture shall be designed to meet the technical specifications and the functional user requirements. This architecture shall be reviewed by IR for its acceptability.

2.5.2 The hardware equipment required at the user end i.e. Zonal headquarters, divisional headquarters, diesel sheds, and lobbies shall be clearly defined by the bidder and procurement shall be the responsibility of the respective IR unit. The requirement of this hardware shall essentially depend upon the data entry and review scheme finalized by IR/purchaser.

2.5.3 Hardware OEM shall be of world repute for the offered category of servers. They shall have presence in the international server market for at least four calendar years, including the current year. Once the specifications are agreed upon, the procurement of the hardware is the responsibility of IR, who may procure it separately or procure it along with the software portion (part A).

2.5.4 The tasks outlined in the Scope of Work document shall not be constrained for lack of server equipment/functionality. In other words, if prior to the procurement any server capacity is required temporary arrangements shall be made. IR shall be willing to provide assistance in making temporary arrangements, if any spare resources are available.

2.6 An indicative server utility and specification is given below for reference:

The hardware proposed by the bidder shall support fast/acceptable response times even at very high concurrent user loads where Concurrent users may be around 50 at a time in the worst condition. Vendor shall describe the proposed architecture for the solution. It shall have:

- *Reference for having demonstrated these technologies in actual production environment.*

- *Performance, High Availability and Scalability:*
 - *Along with scalability, performance and high availability, security shall also be a design element for dealing with data transfers using common infrastructure. Security entails reliable authentication and robust end-to-end confidentiality.*
- *A comprehensive, fully documented disaster recovery and business continuity plan shall be indicated; all costs shall be included and separately indicated.*
- *Application Software/Hardware shall have:*
 - *Built in support for maintaining the client state between successive client calls.*
 - *Many options and algorithms for load balancing amongst servers.*
 - *Capability of clustering of Application Servers both vertical as well as horizontal.*
 - *Capability of clustering Application Servers running on different operating systems as platform. Essentially allow for Mixed Clusters.*
 - *Reference for having demonstrated these technologies in actual production environment.*
 - *Support for hardware load balancers.*
 - *Ability to pull or push data and import /export to Excel, MS Access and Oracle.*
 - *Common Metadata*
 - *Consistent User Interface*
 - *Seamless Navigation*
 - *OS independent*
 - *Seamless scalability of the system*
 - *The methodology used for the sizing of hardware shall be clearly defined*
 - *and shared with IR.*
 - *If client machines need a software installation, then mode of maintenance (central maintenance) shall be available for up gradation/downloading of the software to client machines.*
 - *The out of the shelf system software shall be standard Industry products and working at enterprise level and shall have strong market presence.*
 - *There are a variety of users who may have different types of requirements and options. There shall be role-based security to define policies based on Indian Railway's structure and roles so that any access policy can be applied to a whole group of users through their association with a particular role participating in the rule:*
 - ❖ *Around 800 persons at HQ/Zone/Division Level; these persons shall be able to view and alter/input data through different levels of password protection.*
 - ❖ *Report level Users-The users shall not be able to update any data but have the permissions to view all the reports.*
 - *Issue tracking system shall be a part of the solution being offered.*
 - *Standard Case Tools shall be utilized for complete life cycle of the project.*

- *Logging/Tracking: The application shall provide transaction logs and audit trails by date time and user ID for all tasks covered within it.*
- *The solution shall be built preferably using open standard like SOAP, XML, WEB services, XSL, XSLT etc.*
- *Quality Assurance processes followed for full life cycle of software development shall be indicated clearly and the detailed test plans for specific requirements of IR shall also be given.*

**2.7 Hardware Specification
(minimum)**

Rack type server with two servers, high availability features hot swappable components, including UPS in Rack enclosure

Web server and Database server, Web server with lower specification, shall maintain commonality and serve as backup cluster

Data base server shall have Raid 5 for data redundancy and also auto backup on tape drives

Both servers shall be specified with one CPU each, system shall have room for growth, shall support Unix/Linux OS

<i>Web server</i>	<i>Quad-Core Intel Xeon Processors 5400 series Rack Mount Server - 2 CPU Slots</i>
<i>Chassis Options</i>	<i>Rack Enclosure</i>
<i>Processor</i>	<i>Quad-Core Intel(R) Xeon(R) E5450, 2x6MB Cache , 3.3GHz - 1CPU</i>
<i>Memory</i>	<i>16GB, DDR-2 667MHz ECC 2R Fully-Buffered Memory</i>
<i>Operating System</i>	<i>incl. - Linux or Unix</i>
<i>Hard Drives</i>	<i>300GB 3.5-inch 15K RPM SAS Hard Drive</i>
<i>Power Supply</i>	<i>Redundant 750W hot-plug auto-switching universal 110/220V AC power supplies; UPS module</i>
<i>Connectivity</i>	<i>Optical Fibre network, Ethernet NIC with fail-over and load balancing</i>
<i>Availability</i>	<i>Hot-plug hard drives, Hot-plug redundant power, Hot-plug redundant cooling</i>
<i>Additional</i>	<i>High availability failover cluster support</i>
<i>Hardware Support</i>	<i>3Yr ProSupport for End Users & Mission Critical: (7x24) 4-hour Onsite Service</i>
<i>Database server</i>	<i>Quad-Core Intel Xeon Processors 7000 series Rack Mount Server - 4 CPU Slots</i>
<i>Chassis Options</i>	<i>Rack Enclosure</i>
<i>Processor</i>	<i>Quad-Core Intel® Xeon® Processors 7300 series, X7350, 2.93 GHz, 130W, 8MB cache - 1 CPU</i>
<i>Memory</i>	<i>32GB (8x4096), DDR-2 667MHz ECC 2R Fully-Buffered</i>

	<i>Memory</i>
<i>Operating System</i>	<i>incl. - Linux or Unix</i>
<i>Storage Hard Drives:</i>	<i>3.5" SAS (15k rpm): 4 X 300GB PERC 6/i: SAS 3.0Gb ports with 256MB battery-backed cache for internal</i>
<i>RAID Controllers</i>	<i>I storage</i>
<i>Drive Bays</i>	<i>Internal hard drive bays to support five 3.5" SAS hot-plug hard drives</i>
<i>Optical Drive</i>	<i>Dedicated optical media bay for one Max 8X DVDRW, 8X DVD-ROM or 24X CD-RW/DVD drives; I/O</i>
<i>External Backup</i>	<i>Auto Tape Drives</i>
<i>Communications</i>	<i>Four embedded Broadcom® NetXtreme II™ 5708 Gigabit5 Ethernet NIC with fail-over and load balancing</i>
<i>Additional NIC</i>	<i>Intel Single Port Server Adapter, 10Gigabit, SR Optical, PCI-E x8</i>
<i>Power</i>	<i>1030 W (90V - 180 VAC) - 1570W (180 - 240 VAC) hot-plug auto-sensing redundant power (1+1)</i>
<i>Cooling</i>	<i>Hot-plug, redundant cooling fans</i>
<i>Graphics</i>	<i>Integrated</i>
<i>Availability</i>	<i>Hot-plug hard drives, Hot-plug redundant power, Hot-plug redundant cooling</i>
<i>Additional</i>	<i>High availability failover cluster support</i>
<i>Hardware Support</i>	<i>3Yr ProSupport for End Users & Mission Critical: (7x24) 4-hour Onsite Service</i>
<i>Additional server Hardware</i>	
<i>Monitor</i>	<i>15" LCD</i>
<i>Rack Enclosure</i>	<i>24U; 4-post, Versa rails, sliding rails and Cable Management</i>

2.8 Data entry nodes: These shall be located at the various control/operating units of IR. These shall be of a simple PC configuration that is already available in IR control/operating units. Their requirements shall be estimated by the purchaser depending upon the phased implementation plans.

2.9 Data up linking: all requisite hardware for up linking of remote data entry nodes with the central server shall be identified by purchaser and procured as per implementation phase of GOLD.

3.0 Performance & Environmental Requirements

3.1 The OBPS and the OAU shall conform to the following test parameters (as applicable) detailed in para 3.0 through para 5.0.

3.2 The unit shall meet the requirements of RDSO specification no. ELRS/SPEC/SI/0015/ Rev 1-October 2001 for “Reliability of Assurance specification for Electronic components for use in rolling stocks.”

3.3 The climatic and environmental conditions prevailing in India are the following. The unit shall be designed to work satisfactorily in these conditions:

Atmospheric temperature	(i) Maximum temperature of metallic surface under the sun: 75 °C. (ii) Minimum temperature: -10°C (Also snow fall in certain areas during winter season.
Humidity	100% saturation during rainy season.
Reference site conditions	(i) Ambient temperature: 50 °C (ii) Humidity: 100% (iii) Altitude: 1776 m above mean sea level.
Rainfall	Very heavy in certain areas.
Atmospheric conditions	Extremely dusty and desert terrain in certain areas. The dust content in air may reach a high value of 1.6 mg / m ³ . In many iron ore and coal mine areas, the dust concentration is very high affecting the filter & air ventilation system.
Coastal area	Humid & salt laden atmosphere with maximum pH value of 8.5, sulphate of 7 mg per liter, maximum concentration of chlorine 6 mg per liters and maximum conductivity of 130 micro siemens/cm
Vibration	The equipment, system and their mounting arrangement shall be designed to withstand satisfactorily the vibration and shocks encountered in service as specified in IEC 61373.
Wind speed	High wind speed in certain areas, with wind pressure reaching 150 kg/m ³ .

4.0 ACCEPTANCE TEST

Type and routine test schemes shall be prepared in accordance with the relevant IEC/UIC/IS/AAR specifications and furnished to RDSO for approval. Prototype test shall be conducted on the basis of the approved type test scheme in the presence of the RDSO representative.

The inspection and acceptance norms shall be finalised mutually depending upon the type and routine test requirement otherwise frozen. The acceptance norms proposed shall, however, be submitted along with the offer by the supplier.

A-1. Type and Routine Test

The System shall be tested for functional tests and the test programme shall be finalized at design approval stage between the firm and RDSO.

A-2. Following tests shall be carried out on the prototype unit as per relevant IEC specification or mutually agreed upon test program. Manufacturer shall bear the expenses of the tests.

A-3 The type tests shall be carried out in the premises of the manufacturer of the systems by RDSO.

SL NO	TEST	CLAUSE	TYPE	ROUTINE
1.	Visual inspection	As per the Equipment Drawings	✓	✓
2.	Tolerance & Dimension		✓	✓
3.	Cooling	IEC 60571 clause 10.2.3	✓	
4.	Insulation Resistance	As per Clause-11(b) this spec.	✓	✓
5.	Di Electric		✓	✓
6.	Vibration and shock	IEC 60571 clause 10.2.11	✓	
7.	Performance test on test jig		✓	✓
8.	Voltage surge	IEC 60571.1 clause 10.2.6.2	✓	
9.	Electrostatic Discharge test	IEC 60571.1 clause 10.2.6.4	✓	
10.	Transient susceptibility test	IEC 60571.1 clause 10.2.7	✓	
11.	Radio interference test	IEC 60571.1 clause 10.2.8	✓	
12.	Salt mist test	IEC 60571.1 clause 10.2.10	✓	
13.	Damp heat	IEC 60571.1 clause 10.2.5	✓	
14.	Dry heat up to 70 degree C	IEC 60571.1 clause 10.2.4	✓	
15.	Burn – in	As per Burn-in cycle attached Annexure – 1	✓	
16.	Functional Test	As per test program to be finalized during design approval state	✓	✓

The following clarifications are issued on the tests above.

- 4.1 Visual inspection of Tolerance & Dimension** – The object of visual inspection is to check that the equipment is free from defects and the equipment is as per approved drawing. Bill of materials shall be submitted. The make, rating of equipments subassemblies shall be checked with the details as per approved design. If a change is needed in make or rating of important equipments, sub-assemblies, it shall be intimated and shall have approval of RDSO. The equipment with modified subassemblies shall be given separate revision number. All the important dimensions

shall be measured and shall be in permissible tolerance.

4.2 Insulation resistance and Dielectric test – The insulation resistance with 500 Volt megger shall not be less than 100 M ohms at 70% relative humidity for all the circuits. The dielectric test shall be carried out after earthing special cards if necessary before applying Dielectric voltage. The dielectric test shall be carried out at a test voltage of 1.5 kV rms for 60 secs. The leakage current shall be less than 5 mA.

4.3 Burn in test – The cards used on the equipment shall be subjected to burn – in as per the temperature cycle in Annexure – 1. The cards shall be kept energized during the test. Functional test of each card shall be carried out after the burn in test. This shall be part of internal test by manufacturer, whose results shall be submitted during routine test.

5.0 VALIDATION TEST

Validation tests like wiring integrity and installation checks, Hi-pot, insulation resistance and self tests, complete performance establishment, load box examination, parasitic load management verification, track test etc. shall be carried out on the load box at any nominated place mentioned by IR to establish the performance capability and integration of the microprocessor system with other locomotive systems.

6.0 HARDWARE DETAILS: The successful tenderer shall provide detailed description of proposed solution covering the architectural details and component-based design.

7.0 SCOPE OF WARRANTY/AMC OF HARDWARE

1. The bidder shall provide warranty in respect of the hardware for 1 years included in the contract value and quote separately for AMC charges for the second through to sixth year. These AMC charges may not be considered for evaluation of the commercial bid.
2. Delivery, transportation to site, commissioning and installation of Hardware shall be the responsibility of the bidder.
3. Total System Integration (e.g. RDBMS along with Active-Active installation) shall be the responsibility of the bidder.
4. Bidders shall disclose as to how they propose to provide onsite support for maintaining system health and fine-tuning system performance.
5. Documentary evidence for back-to-back agreement with the OEM to provide support including availability of spares and software upgrades for 5 more years from date of expiry of warranty is required to be attached along with the offer.
6. All licenses supplied shall be unlimited (no expiration with time).
7. The bidder shall ensure through documentary proof from the OEM that RDBMS shall be released in future on the machine supplied by him for a period of at least six years from the date of installation.
8. The vendor shall provide sufficient documentary evidence that the offered environment (i.e. Hardware platform, OS, RDBMS, and Active-Active solution together) has been successfully tested under the Lab conditions.
9. OEM shall certify the binary compatibility between the Production Servers and Development/Offline Servers offered.

10. During the warranty period the vendor shall maintain the system in good working order. The service shall consist of preventive and corrective maintenance and shall include:
- i. Carrying out of all necessary repairs and replacements of parts without any additional cost.
 - ii. Shall also include supply and installation of patches, upgrades and tuning of the operating system.
 - iii. The vendor shall have a written commitment from the OEM to provide onsite support in case required.
 - iv. Maintenance coverage shall be on site all working days during day time (8 am to 8 pm) and at least 99.5% (or more) uptime.
 - v. The preventive maintenance shall be carried out at least once a month. The preventive maintenance schedule shall not affect the online operations. If the preventive maintenance brings application to halt, then the preventive maintenance time shall also be included in the down time.
 - vi. Bidder/server OEM shall have to maintain their own inventory of spares so as to give fast and efficient service.
 - vii. The engineer of bidder/ server OEM shall reach the site within 6 hours. In the event of a part failure, i.e. CPU/memory card etc the replacement shall be installed within 24 hrs.
 - viii. The bidder shall provide the contact number i.e., home address, residential phone number, mobile phone number etc. of the engineers, Project Managers, Regional Managers and Country Managers of server OEM.
 - ix. The server OEM support provided shall be of the highest level and the same shall be very clearly mentioned in detail along with complete escalation mechanism in case of a failure.
 - x. The system shall be treated as down if there is disruption of services due to system failure at a given site or location.
 - xi. For the purposes of calculating the down time, the starting time shall be the lodging of the complaint.
 - xii. In case of down time beyond 99.5% uptime, both during warranty and post warranty AMC shall attract the penalty clause, a cash penalty of Rs. 2000/- per hour or part thereof shall be levied.
 - xiii. In case the problem is not resolved within the time slot allowed by Railways, the next planned downtime shall also be added in the down time for charging of penalty.