Schedule 5(q)

Traffic Management System (TMS)

California High-Speed Rail Authority

Standard Specifications

TSCC Specifications

SPEC-0021 – Traffic Management System (TMS)

Rev. 0.0

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TABLE OF CONTENTS

1 INTRODUCTION

1.1 Scope of the technical specification

1.1.1 The scope of this Technical Specification is to define the Authority's requirements for the **Traffic Management System**, hereinafter: **TMS**.

1.1.2 The functional architecture of the TMS alongside other Train Control Systems is presented in Appendix A.

1.1.3 The requirements are formulated using the following words and their meanings:

- "Shall": Indicates mandatory requirement that must be strictly implemented. Any impossibility to fulfil this requirement must be agreed through a derogation case (see change management procedure).
- "Should": Indicates preferred course of action, recommendations. No agreement of derogation is necessary, there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course - for example the same goal is reached by other solutions, which are permissible within the binding standards or documents.
- "Must": Indicates an obligation or a mandatory requirement.
- "May": Indicates a permissible course of action within the limits of the standards, but which is not mandatory to be fulfilled.

2 REFERENCE STANDARDS AND DOCUMENT

2.1 General

2.1.1 The TSCC Contractor shall apply the in-force standards, guidelines and specifications provided in this technical specification for all stages of the design, test, manufacture, supply, delivery, assembly, installation, testing, commissioning, training, operations and maintenance.

2.1.2 All generic standards to be used are provided in: Technical Contract Requirements.

2.2 Standards

2.2.1 The following specific standards to be used for TMS are listed below.

ID	Code	Title
[R25]	ISO 11064	Ergonomic design of control centers
[R26]	TAP TSI	Telematics Applications for Passenger Service TSI
[R27]	EN/ISO 62682 standard	Principles for managing alarms systems in process industries
[R28]	EULYNX Baseline Set 4 Release 4	EULYNX Baseline Set 4 Release 4

TABLE 13 – LIST OF APPLICABLE STANDARDS

3 TERMS, DEFINITION AND ABBREVIATION

3.1.1 All the terms, definitions, and abbreviations are provided in the Glossary of Terms, Abbreviations and Definitions.

4 SYSTEM DESCRIPTION

4.1 Purpose of the TMS

4.1.1 The TMS system shall perform the following main functions:

- Timetable and simulation,
- Interface with other external timetable applications,
- Capacity management,
- Real-time traffic management in mainline and stations,
- Normal and degraded operation with predefined contingency plans
- Traffic Management at Facilities,
- Efficient coordination with national emergency / security authorities,
- Efficient coordination with the Train Dispatcher,
- Coordination of maintenance,
- Maintenance work monitoring and engineering possessions,
- Monitoring of energized track sections,
- Tool for training, playback and analysis of past operations,
- Diagnostic tool,
- Manual Routing of Trains
- Dispatching operations.

4.2 TMS Definition

4.2.1 The TMS shall be deployed in the Fresno OCC.

4.2.2 The TMS shall provide the Dispatcher HMI for all the traffic management tasks.

4.2.3 Yard Controller HMI shall be provided in the local facilities (LF), except for TCF.

4.2.4 Note: California HSR Project includes passenger stations, but also at a minimum trainset maintenance facility (LMF and HMF), Maintenance of Way Facility (MOWF) and Train Certification Facility (TCF) locations.

4.3 TMS and ERTMS

4.3.1 The Traffic Management System on main line shall include:

- Traffic Management System,
- Maintenance work monitoring and engineering possessions.

4.3.2 The TSCC Contractor shall propose its most efficient and secure solution for engineering possession and catenary protection.

4.3.3 TMS shall be interfaced with the following TCS subsystems for the purpose of following functions (list not limitative):

4.3.3.1 Radio Block Centre (RBC):

- Movement Authorities.
- Text message,
- Train Data (train running number, position and speed),

- Temporary Speed Restriction (TSR),
- RBC equipment status, alarms, and events.

4.3.3.2 Interlocking (IXL):

- Route setting,
- Trackside equipment monitoring and control,
- Temporary Shunting Area (TSA),
- IXL and TMS status, alarms, and events.

4.4 TMS Operational Context

4.4.1 The TMS system shall enable:

- 24h service all year round (with required traffic stops for maintenance work).
- Management of train movements along the line with the given headway.
- Bidirectional operation on main line.
- Management of interfaces with other subsystems of railway system.
- Recording of the traffic information and operational alarms.

4.4.2 The TMS system shall comply with the operational rules applicable on the CHSR line and shall allow safe movement of all trains for CHSR line at maximum operational speed.

4.4.3 The TMS system shall be deployed over the entire railway network on the CHSR line, managing all types of railway infrastructure, e.g., the main line and Facilities.

4.4.4 TMS shall support multiple operational roles based on operational needs, each role shall be open to configuration or re-configuration by the Authority. Example roles are defined in Chapter *5.4.5 User Management (UM)*, functions and responsibilities will be defined by the operational procedure to be developed and approved by the Authority.

4.4.5 The examples of TMS operational roles are listed below:

- Supervisor,
- Dispatcher,
- Offline Timetable Operator,
- Regulator,
- Trainer (simulation)
- Yard Controller,
- TMS Administrator.

4.5 Design Life

4.5.1 The design life requirements of the TMS System shall be 30 years.

4.5.2 The TSCC Contractor shall ensure that the manufacturers will be able to produce TMS system components, with equal or better technical specifications, throughout the required operational lifetime, recognizing the potential for successive generations and evolving sensor technology.

4.5.3 Any equal or better technical specifications element should be able to be integrated “out of the box”, with no re-work of existing systems, components or other element’s part from the single item being replaced.

5 SYSTEM REQUIREMENT

5.1 General Requirements

5.1.1 The TSCC Contractor shall design, install, verify and validate, test and commission, organize the training, provide warranty services and provision of defect notification period services for the TMS roll out.

5.1.2 The TMS for mainline will be technically implemented into the Operational Control Centre (OCC) in Fresno.

5.1.3 The TMS shall conform to California legislation, to US Code of Federal Regulations (CFRs) and comply with agreed California High Speed Rail operations.

5.1.4 The TMS shall be deployed as follows:

- Main line TMS operation workstations in the OCC Operating Floor,
- TMS servers in the OCC equipment rooms,
- TMS workstation in local facilities. Traffic management for the following local facilities: MOWF/LMF/HMF shall be managed by a dedicated Yard Controller, who will be located at the facility.

5.1.5 The TMS shall implement functionalities and technologies with high level of flexibility, to allow easy modification, expansion and reconfiguration according to the traffic management organization and consistence of traffic (as it is expected that frequent adaptation of the operational control center and organizational structures may be required during the TCS subsystem lifetime), and be capable to adapt to different possible organizational and operational models that could be applied to CHSR line.

5.1.6 The TMS shall provide at least the following main functions which shall conform to the requirements of legislation of California and shall be implemented to ensure the process of operation of CHSR:

- Real-time image of the entire line,
- Permanent control across the whole network,
- Automatic and manual route setting,
- Real timetable management
- Supervision of train movements and train tracking,
- Supervision of the whole line,
- Timetable conflict resolution,
- Priority management,
- Regulation,
- Temporary Speed Restriction management (TSR),
- Visualization (no possibility of action) of the alarms which could impact the normal operation from the following systems: Hazard Detection and Early Warning Systems.
- Works train movement route setting,
- Engineering possessions management for maintenance and engineering works, (including indication of Maintenance works protection measures.)

5.1.7 The TMS shall be able to:

- Remotely control the computer-based interlocking system,
- Generate route setting commands to the interlocking,
- Process timetable data coming from both:

TMS internal timetable tool,

a different (external) timetable tool or application, that the Authority may elect to procure as a totally different timetable system, other than the TMS internal timetable tool,

- Perform capacity management,
- Perform traffic regulations to optimize the operation,
- Localize and identify trains by tracking all train movements,
- Record all relevant events of the operational day for later statistical evaluations and for post-incident analysis,
- Back up the overall supervision and control of all train movements by a data logging and playback system,
- Individual management of objects (turnouts for the various functions as turnout blocking, inhibition, individual control, or block sections),
- Provide real-time display,
- Provide alarms and associate fault diagnostic information for the entire Signaling System.

5.1.8 All stations should be remotely controlled from the Fresno OCC TMS.

5.1.9 The TMS shall be able to manage, at least, the following types of trains:

- High Speed Passenger trains,
- Maintenance trains,
- Testing trains,
- Emergency trains.

5.1.10 The TMS shall provide:

- Fully automatic route setting in the regular operation mode and partially automated in degraded modes,
- Manual route setting in case of emergency operation, or in the event of Automatic Route Setting functionality being unavailable.

5.1.11 The TMS shall be able to manage operation on CHSR main line, including:

- Passenger stations: Merced, Madera, Fresno, Kings/Tulare, Bakersfield.
- Transfer tracks to facilities (depending on the proposed solution for the track configuration and the operational needs).

5.1.12 Dedicated tracks separating the main line from facilities shall enable any train movement from the main line to the facilities and from the facilities to the main line. Those tracks are called “Transfer tracks”. In case a train should enter the main line from the facilities, the Local Control shall request authorization from the main line Dispatcher.

5.1.13 The TMS shall ensure the following interfaces with other TSCC systems:

TCS Systems (other than TMS)	**TMS**		
	Receive, Process & Send Data	Monitor (visualization on Dispatchers HMI)	Command (actuate)
RBC	Yes	Yes	Yes

IXL - Interlocking	Yes	Yes	Yes
Power SCADA System	Yes	Possible	No
LVPD (Low Voltage Power Distribution)	Yes	No	No
DCN (Digital Communication Network)	Yes	No	No
Cybersecurity	Yes	No	No
Hazard Detection and Early Warning System (HDEWS) (incl. all Detectors and Sensors System)	Yes	Possible	No
Integrated Control and Supervision System	Yes	Possible	No
Passenger Information Display System / Public Address System	Receive & process	No	No
Network Synchronization and Time Distribution System (Master Clock System)	Yes	No	No

TABLE 14. TMS INTERFACES WITH OTHER TSCC SYSTEMS

5.2 Environmental Requirements

5.2.1 TMS's equipment is hosted in the OCC, passenger stations and facilities buildings. The relevant environmental requirements apply.

5.2.2 The TMS's equipment shall meet the environmental requirements described in the Scope of Work.

5.3 Operational Requirements

5.3.1 The TMS shall allow the Authority to operate the CHSR main line as described in this Technical Specification and in the CHSR Operational Concept in Nominal, Degraded and Emergency mode.

5.3.2 The TMS shall allow the Authority to maintain the CHSR main line as described in this Technical Specification and in the CHSR Maintenance Concept.

5.3.3 The operational requirements at the level of detail needed for TMS design will be specified later by the Authority, with coordination with the TSCC Contractor.

5.4 Mainline TMS Functional Requirements

5.4.1 Timetable, Infrastructure Construction and Simulation:

5.4.1.1 Offline Timetable

5.4.1.1.1 The TMS shall provide an offline timetable function allowing the construction and management of CHSR.

5.4.1.1.2 The TMS offline timetable shall meet the requirements of *TAP TSI [R2].*

5.4.1.1.3 The Offline timetable function shall provide automatic timetable generation including automatic detection and automatic conflict resolution.

5.4.1.1.4 A dedicated HMI shall be provided for this activity. This HMI shall provide all the tools in an ergonomic and user-friendly environment, timetable construction and simulation shall

be realistic and based on the railway network topology, rolling stock characteristics and other parameters to be agreed prior to the design.

5.4.1.2 **Timetable Management (TTM)**

5.4.1.2.1 TMS shall provide an import function allowing timetable import from the Offline timetable function according to all requirements of *TAP TSI [R2].*

5.4.1.2.2 The import function shall include a timetable consistency check step before timetable storage.

5.4.1.2.3 TMS shall include a Timetable Management function that support the management (creation, modification, selection…) of predefined electronic timetables.

5.4.1.2.4 TMS shall automatically select the timetable for the current operating day according to the calendar of operation.

5.4.1.2.5 TMS shall allow a manual selection of an operating timetable among the set of available timetables.

5.4.1.2.6 TMS shall allow the content of the current timetable to be adapted manually or automatically such as but not limited to:

Adjustment of departure time,

Addition of extra journeys,

Modification and cancelation of existing journeys.

5.4.1.2.7 TMS shall provide convenient functions and HMI to support offline timetable management, including but not limited to:

Generation of a complete and coherent timetable using a graphical time-distance chart,

Insertion into the timetable database,

Printing of timetables.

5.4.1.2.8 Timetables shall be the primary source of information for other functions typically Automatic Train Reporting, Automatic Route Setting, Automatic Train Regulation, certain features of Train Description function and also Passenger Information system.

5.4.1.2.9 The TTM function shall provide for the basic preparation, building, storage, editing, loading etc. of Base and Operational timetables.

5.4.1.2.10 The TTM function shall be able to adapt the timetable for seasonal, weekend, holiday and exceptional effects and shall enable Dispatchers to edit and modify the timetable information both off-line and online.

5.4.1.2.11 Timetable data shall include train identity, type, class, time profile, stopping pattern, routing information etc.

5.4.1.2.12 The TTM function shall provide the loading, activation, and editing of appropriate daily operational timetables.

5.4.1.2.13 The TMS shall provide an export function allowing export timetable according to the format required by *TAP TSI TAP TSI [R2].*

5.4.1.3 **Integration of the external Timetabling data from other External applications**

5.4.1.3.1 In the beginning or throughout the Operations period and at any time, the Authority may elect to procure an independent timetable planning system, other than the TMS internal timetable tool.

5.4.1.3.2 TMS shall provide an import function allowing timetable import from the External timetable tool.

5.4.1.3.3 The import function shall be clearly specified in order to have a precise definition of the data format that will be imported.

5.4.1.3.4 The import function shall include a timetable consistency check step before timetable storage.

5.4.1.3.5 All other requirements stated above in this section are mandatory.

5.4.2 Traffic Operation and Real Time Traffic Management

5.4.2.1 Route Setting

5.4.2.1.1 The TMS shall allow at least the following commands:

Route setting (Main route, Shunting route, Call-on route),

Fleet mode (the route remains in a locked state),

Route cancel (Main route, shunting route, Call-on route), including partial cancellation,

Emergency Route Release and group replacement

Call-on route: certain locations are permitted to allow more than one train into a single section, e.g. to join trains or enable 2 trains to use one platform. The movement of the second train into an occupied section is authorized by setting a "call-on" route...

5.4.2.1.2 The TMS shall allow the management of the Shunting route allowing the authorized trains to move to permanent shunting areas or to temporary shunting areas as works (application and management of predefined shunting areas).

5.4.2.1.3 The TMS shall allow the management of call-on routes for the trains in On-Sight mode allowing these trains to enter occupied sections.

5.4.2.1.4 The TMS shall allow the management of Main routes for the trains in FS mode in normal operation.

5.4.2.1.5 The TMS shall allow setting "extended routes" (composed of several routes) within an interlocking by selection of the route entrance and the route exit limits.

5.4.2.1.6 It shall be possible to place certain routes into "Fleet Mode" such that, on passage of a train, route normalization is inhibited (route is dynamically (partially) released, and the new route could be set when conditions ahead allow).

5.4.2.1.7 TMS shall enable Dispatcher to execute emergency route release and group replacement controls.

5.4.2.1.8 Overrun alarms (i.e. when informed by the RBC that a train entered in trip mode when passing a Marker Board at danger) shall be raised on the TMS for the dispatcher to take appropriate actions.

5.4.2.1.9 The TMS shall perform a preventive check to avoid setting a route, if the OCS is not powered (if so, trains shall be stopped in the appropriate section),

5.4.2.1.10 These checks shall be performed in manual and automatic (ARS) mode.

5.4.2.1.11 Detailed functionality and graphical user interface of Route Setting function to be proposed by TSCC Contractor prior to the detailed technical design and approved by the Authority.

5.4.2.2 **Automatic Route Setting (ARS)**

5.4.2.2.1 The TMS shall provide Automatic Route Setting functionality (ARS).

5.4.2.2.2 The ARS function shall automatically provide route setting requests to the interlocking for routes throughout the controlled area and shall provide the following facilities:

Be capable of operating any booked service to its planned path from the point of Inception to the point of termination,

Be capable of automatically changing a Train Identification (TI) where a train has completed one booked path and is about to embark on another booked path, and

Be able to regulate path conflicts that arise from perturbed running of booked services, minimizing the overall delay.

5.4.2.2.3 The ARS function shall be sub-divided into "areas" which may be related to interlocking areas.

5.4.2.2.4 It shall be possible for Dispatchers to either enable or dis-enable ARS for each track area separately via HMI. An indication of the status of each area shall be given to the Dispatcher.

5.4.2.2.5 The train service data for the ARS will be derived from the timetable in real time and shall be updated automatically to consider regulation information.

5.4.2.2.6 The ARS function shall be provided with the identity and location of each train by the Train Identification (TI) function.

5.4.2.2.7 The ARS function shall be capable of performing route setting and train regulation for the whole area under control of the TMS.

5.4.2.2.8 Route settings shall match the planned timetable when all trains are running as scheduled.

5.4.2.2.9 When train services are disrupted the ARS function shall make decisions to regulate the service to achieve minimum overall delay to trains.

5.4.2.2.10 Means shall be provided to enable such ARS decisions to be automatically referred to the Dispatcher for vetting and acknowledgement prior to implementation.

5.4.2.2.11 When the ARS function is not able to bring an optimum solution, it shall keep trains running in line with the general timetable plan or contingency plan.

5.4.2.2.12 ARS action shall be taken on the basis that trains shall only have routes set for them once they have been recognized by the ARS system and are included in the timetable data.

5.4.2.2.13 When the ARS function is enabled, manual route settings shall also be available and shall always take priority over automatic operation.

5.4.2.2.14 The Dispatcher shall be able to deactivate the ARS function at least for:

A train,

A station,

Several stations.

5.4.2.2.15 Should communication to one or more interlocking be unavailable, ARS shall continue to operate in all areas not affected by the failure.

5.4.2.2.16 The Dispatcher shall be able to:

Operate the ARS function and receive information from it,

Selectively signal individual trains by ARS or manual means and be able to determine by which method each train is operated,

Determine the next forecasted route of the train by the ARS,

Ascertain the timetable under ARS control,

Engage and disengage ARS areas.

5.4.2.2.17 The system shall be interlinked with the Train Identification function such that display of Train Identification for ARS and non-ARS trains shall be clearly distinguishable by use of distinctive colors.

5.4.2.2.18 The ARS function shall be able to implement the regulation decisions including real-time timetable adjustment.

5.4.2.2.19 The TSCC Contractor shall provide the most efficient Automatic Route Setting function avoiding unnecessary delays of trains.

5.4.2.2.20 The ARS function shall appropriately route an identified train to the correct destination.

5.4.2.2.21 Manual route setting, and cancellation, shall be available in parallel with ARS and shall not cause additional activity for the Dispatcher because of the ARS being present.

5.4.2.2.22 Routes set by ARS function shall be displayed in an identical manner to those set manually.

5.4.2.2.23 Routes may only be set by ARS functions when all the following conditions are satisfied:

The train is approaching a point where route setting is required,

The train has an entry in the timetable or is running to a standard pattern,

The train is progressing along a scheduled route or a permitted alternative route,

The train type is suitable to enter the route,

The next route required is designated as requiring setting by the ARS strategies,

The train is a designated ARS train.

5.4.2.2.24 Commands to set a route shall only be sent to an interlocking by ARS where such a route:

is available to be set,

is an ARS route,

lies in an area which is enabled for ARS operation.

5.4.2.2.25 Oversetting of routes shall not be permitted by the ARS system even where this facility is available manually.

5.4.2.2.26 In the event of any of the following occurring within an ARS area, then such an area shall immediately be dis-enabled and shall revert to manual control:

manual cancellation of a route,

identification of an incorrect sequence of axle counter's operation based on information received from interlocking,

initiation of Workstation control,

ARS working may only then be re-established by the Dispatcher.

5.4.2.2.27 The ARS function shall set routes ahead of train movements to the following criteria:

Routes shall be set far enough ahead of train movements to ensure that drivers will not receive restrictive signals unnecessarily,

Routes shall not be set unnecessarily far ahead to not impair the efficiency of the train regulation.

5.4.2.2.28 Suitable ARS alarms shall be generated for each of the following circumstances:

Changes of state of the ARS function or of any area within it becoming either available or unavailable,

The inability to correlate train descriptions in the timetable with those of trains in the Train Identification's function,

Trains being run to a path not prescribed to them in the timetable,

The inability to set a route for any train,

Trains which have had a route set for them fail to move within 5 minutes.

5.4.2.3 After TMS is put in operation, the Authority shall be able to configure and adjust the ARS function parameters determining the route preparation.

5.4.2.3.1 Detailed functionality and graphical user interface of ARS function to be proposed by the TSCC Contractor prior to the detailed technical design and approved by the Authority and train dispatchers.

5.4.2.4 **Automatic Train Reporting (ATR)**

5.4.2.4.1 The principal functions of the Automatic Train Reporting (ATR) system shall be:

To monitor real-time train running performance against timetable,

To provide statistical data for analysis and timetable preparation.

5.4.2.4.2 As trains progress through the system their actual progress shall be monitored and compared with the operational timetable data.

5.4.2.4.3 For the purpose of monitoring station stops, the arrival time at a station is the time when the track detection system preceding the loop line or passing road is occupied and then cleared (usually a point track).

5.4.2.4.4 The departure time from the station is the time when the first track beyond the loop line or passing road is occupied (usually a point track).

5.4.2.4.5 System outputs shall be in the form of Workstation's displays, hardcopies and storage devices in respect of:

Time-Distance Graphs,

Train Run Reports, Schedules etc.,

Stored ATR data.

5.4.2.4.6 The Automatic Train Reporting function shall provide exports to Transmodel standards.

5.4.2.4.7 Displays of Train Graphs shall incorporate pan and zoom techniques in both axes.

5.4.2.4.8 The ATR function outputs shall contain information in respect of train running, which is planned, actual, future and predictive and each shall be shown in a distinctive manner.

5.4.2.4.9 Outputs shall be available on a routine basis and on demand.

5.4.2.4.10 Dispatchers shall be able to call up information by exception using selection criteria. This shall include the ability to select the extent of variance from the timetable for specific reports.

5.4.2.4.11 The ATR function shall interlink with the Train Identification function such that TD displays are able to highlight the extent of delay, i.e. variance from the timetable.

5.4.2.4.12 Delay criteria and form of display shall be subject to the specific approval of the Authority.

5.4.2.4.13 Online data storage shall be provided, enabling users to access and browse the previous 60 months' records at any time. It shall be possible to extend the storage time for specific types of data if required.

5.4.2.4.14 The ATR function shall also store records in a suitable manner to permit the transfer of each month's records to external processors or to suitable media for archival storage.

5.4.2.4.15 Detailed functionality and graphical user interface of ATR function to be proposed by the TSCC Contractor prior to the detailed technical design and approved by the Authority.

5.4.2.5 Signaling Commands (SIG)

5.4.2.5.1 The TMS shall be able to operate with different types of interlocking and RBC using the EULYNX standard protocols.

5.4.2.5.2 The operation of the Signaling System (TMS+ IXL+RBC + Wayside) shall be unified within TMS, no specific HMI shall be required, and it shall be possible to issue commands to all parts of the Signaling System, RBC and IXL, in the same HMI view.

5.4.2.5.3 The Safety critical commands shall be defined and implemented by the TSCC Contractor during design stage and follow the RAMS process.

5.4.2.5.4 Inhibit, Blocking or protection functions (of turnouts, etc.), when initiated by the TMS, shall be managed as vital functions (SIL2 at least, the definition of the appropriate security level will be the responsibility of the TSCC Contractor).

5.4.2.5.5 Dispatchers shall have the possibility to issue a route command by interacting on the presentation of the start and end signal/markerboard of the route. In case more than one route is possible to be set between the start and end signal/markerboard, all possible routes shall be displayed for selection.

5.4.2.5.6 TMS shall generate requests to the IXL, to enable individual or group management of signaling objects (turnout blocking, inhibition, individual control, block sections, Signal replacement....).

5.4.2.5.7 TMS shall enable to manage emergency stops using a Signal group replacement command to set a group of signaling Marker Boards to a Stop aspect.

5.4.2.6 Double and simple commands

5.4.2.6.1 The commands can be done:

Double command with confirmation (safety related command),

Simple command.

5.4.2.6.2 All safety-related commands shall be done with confirmation.

5.4.2.6.3 Safety related commands shall be at least, but not limited:

Engineering possession,

TSR,

Cancelation of emergency stop,

Section liberation (axle counter reset-restore operation),

Train index modification,

Track condition cancelation (low adhesion, radio hole etc.),

Emergency route release,

Individual management of the objects,

Remote control authorization,

SR, OS and SH mode authorization,

ETCS markerboards unblocked.

5.4.2.6.4 The TSCC Contractor shall define all safety related commands, and the solution put in place in order to manage these commands. Graphical user interface prior to the detailed technical design shall be approved by the Authority.

5.4.2.7 Train Identification (TI)

5.4.2.7.1 The Train Identification function (Ti) shall meet all requirements of the *TAP TSI*.

5.4.2.7.2 Train identifications shall generally be subject to the following characters criteria:

A letter followed by numbers,

A directional arrow is positioned at the beginning or end of the TI as appropriate.

5.4.2.7.3 The TSCC Contractor shall propose the train description rules for the Authority's approval.

5.4.2.7.4 Dynamic TI displays shall be presented on screens and follow the progress of the trains.

5.4.2.7.5 The identification shall be displayed by replacement of a short section of track mimic with the TI at the location concerned, which shall then revert to normal track mimic as the TI moves on.

5.4.2.7.6 The TI function shall be capable of dealing with joining and separation of trains, more than one train occupying a track section etc.

5.4.2.7.7 Comprehensive command facilities shall be provided including:

Enter, delete, replace, or modify TIs,

Edit manually and system generated TI,

Search for the location of a specific TI; and

Identify the TI at a specific location.

5.4.2.7.8 The TI function shall continue to operate under degraded and/or unusual input conditions:

Train detection system failures (unknown, non-connected trains or train has lost the connection),

Turnout indication failures,

Trains passing End of Authority,

Detection of the incoherence between TD and train running number entered by the driver; and

Several trains on the same track section.

5.4.2.7.9 When the system detects the presence of an unknown or non-connected train, it shall first allocate a system generated identification to the train and then generate a prompt/alarm for the Dispatcher.

5.4.2.7.10 The system generated train identification shall be linked to train movement until the Dispatcher responds to the unknown train prompt or otherwise alters the train number.

5.4.2.7.11 Where a blocked track becomes occupied, the unidentified train identifier shall be replaced by an appropriate train identification.

5.4.2.7.12 Early transfer and display queuing of TIs for approaching trains is required to assist train regulation etc.

5.4.2.7.13 At borders with non-equipped sections, if any, or in other areas where trains enter the TMS area, TIs shall be entered manually or automatically via a Timetable Management system with appropriate confirmation by the Dispatcher. Where manual entry is required manual train queue display facilities shall be provided to automate assigning of TIs as trains enter the area.

5.4.2.7.14 The train numbers (all equipped with onboard ETCS) shall be displayed on the Workstation's displays and the Video Wall Display next to the marker of the exact train position.

5.4.2.8 **Time-Distance Graph (TDG)**

5.4.2.8.1 The Time-Distance Graph function (TDG) serves as the main user interface for the operation management.

5.4.2.8.2 The TDG function presents graphically all train movements controlled by the TMS in real time.

5.4.2.8.3 The TDG function shall present all relevant planned data and the real time data for the railway operation.

5.4.2.8.4 Planned data shall be retained in the time-distance train graph when modified.

5.4.2.8.5 In the TDG seamless scrolling in both directions (time and position axis) shall be possible.

5.4.2.8.6 Within the TDG, it shall be possible to indicate/display the area of responsibility.

5.4.2.8.7 Within the TDG, the Dispatcher shall have the possibility to switch the indication of the area of responsibility on and off.

5.4.2.8.8 Train identifications shall be displayed in the time-distance graph.

5.4.2.8.9 The following information shall be displayed as a minimum:

Train progress,

Conflicts (routes, platforms, etc.),

Each type of train identified with dedicated color; and,

Differentiation between the train run and extrapolated path.

5.4.2.8.10 Detailed functionality and graphical user interface of TDG function to be proposed by the TSCC Contractor prior to the detailed technical design and approved by the Authority.

5.4.2.9 **Temporary Speed Restrictions (TSR)**

5.4.2.9.1 The TMS shall allow the management of Temporary Speed Restriction (TSR) on the entire CHSR main line to limit the maximum speed allowed by infrastructure.

5.4.2.9.2 The TSR function shall allow:

To insert the TSR in the timetable,

Automatic setting of the planned TSR. These shall be submitted to Dispatcher's approval,

TSR manually set by the TMS Dispatcher; and

Modification/Cancelation of the planned TSR.

5.4.2.9.3 The Dispatcher shall have the possibility to define, store, re-load, modify and delete TSRs.

5.4.2.9.4 The Dispatcher shall have the possibility to define TSR by defining a start and end using operational kilometers (miles) or track section(s).

5.4.2.9.5 The cancelation or revocation of the TSR shall be done in a safe way. At least the Dispatcher shall confirm the cancelation of the TSR.

5.4.2.9.6 TMS shall support the Dispatcher during the definition of a TSR by entering known information and standard values in related input menus.

5.4.2.9.7 The standard values of the TSR shall be predefined for the Dispatcher and be adjustable only by the system administrator.

5.4.2.9.8 Within ETCS areas, the TMS shall command the definition and deletion of TSRs to the ETCS and receive from it the acknowledgement/rejection of TSR application.

5.4.2.9.9 The Dispatcher shall have the possibility to display all free-defined and pre-defined TSRs including the current status of the TSRs per track, per station, per line, per area.

5.4.2.9.10 Within the TMS, it shall be possible to plan the processing of TSRs as tasks within the timetable management (TTM).

5.4.2.9.11 TMS shall transmit the defined or re-loaded free-defined TSRs to the relevant Interfaced systems.

5.4.2.9.12 The Dispatcher shall have the possibility to activate and deactivate a TSR manually.

5.4.2.9.13 Within the TMS, it shall be possible to activate a TSR automatically. These shall be submitted to Dispatcher's approval.

5.4.2.9.14 The TSCC Contractor shall propose a method for entering TSR limiting as possible human error.

5.4.2.9.15 TSR shall be applied automatically in case of high wind.

5.4.2.9.16 The TMS function of the TSR shall be at least SIL2, the definition of the appropriate security level will be the responsibility of the TSCC Contractor.

5.4.2.10 **Regulation (REG)**

5.4.2.10.1 The Regulation function shall automatically compute the real-time schedule of trains and raise an alarm to the Dispatcher in case of critical delays (it shall be possible to configure parameters of the critical delay by the Authority for different types of trains).

5.4.2.10.2 The Regulation function shall include the following functions:

Figure out in real time optimal estimated schedule, including the regulation measures allowing the best operation,

Put in place in real time this optimal schedule,

Detection of the conflicts at points of convergence,

Display to the Dispatcher information as well as the tools allowing them to modify schedule and anticipate any major perturbations.

5.4.2.10.3 The Regulation function shall also perform:

- Conflicts resolution between the trains including considering the train priority,
- Conflicts resolution over single line sections between opposing trains including sections of single line working in respect of booked maintenance work,
- Departure management of the trains from the stations.

5.4.2.10.4 The Regulation function shall detect and display real-time and extrapolated conflicts, including:

- Time-Distance Graph,
- Traffic regulation alarms displayed on the workstation of the Dispatcher.

5.4.2.10.5 The train regulation function shall process the following commands from the Dispatcher:

- Add or remove a train from the regulation process,
- Assignment of a journey to a train,
- Enable or disable the traffic regulation alarms,
- Identification of delays.

5.4.2.10.6 The TMS shall identify a train as ahead or delayed in accordance with the timetable when the train is ahead or delayed after departing from a station.

5.4.2.10.7 The TMS shall clearly display to the Dispatcher, train identified as ahead or delayed.

5.4.2.10.8 The TMS shall be able to display countdown information before train departure.

5.4.2.10.9 The ARS function must regulate, at least but preferably better, a competent and experienced Dispatcher.

5.4.2.10.10 The system shall resolve all day-to-day regulation conflicts between trains whose route setting is under ARS control.

5.4.2.10.11 Calculations must consider all trains affected by a predictable regulation.

5.4.2.10.12 Regulation of trains shall be based on the following principles:

When all trains are running in accordance with the timetable.

When running out of course the ARS system must minimize delay to all trains affected (e.g., where two trains are approaching a point of conflict in one direction the delay experienced by the second train as a result of ARS regulation must be factored into the delay calculation).

Each train's delay shall be weighted according to priority using an appropriate weighting system.

Timetable order shall be maintained where the weighted delays incurred in doing so are minimal.

5.4.2.10.13 The Regulation function shall process an updated schedule considering at least the following information:

Theoretical schedule,

Train’s location in real time,

Train mode information (ETCS mode, etc.).

5.4.2.10.14 Infrastructure information (wayside equipment failure, occupied tracks, TSR, …).

5.4.2.10.15 The regulation shall satisfy at least the following objectives:

Minimum headway,

Punctuality,

Minimum energy consumption,

Minimum client waiting time.

5.4.2.10.16 To respect the minimum headway objective, the forecasted optimal schedule shall be as close as possible to the theoretical headway defined for CHSR line. The TSCC Contractor shall define the criteria with their ponderation and parameters allowing them to evaluate this objective.

5.4.2.11 **Conflict Detection**

5.4.2.11.1 The conflict detection function shall forecast the development of railway operation regularly in forecasted interval.

5.4.2.11.2 The conflict detection forecast is based at least on the status of the current railway operation, the status of the current resource base and the current operational timetable.

5.4.2.11.3 The timeframe used by the conflict detection function shall be adjustable per area by the Dispatcher.

5.4.2.11.4 It shall be adjustable by the Authority whether the conflict detection forecast uses the remaining driving time reserves.

5.4.2.11.5 The conflict detection function shall detect any conflict along the forecasted railway operation.

5.4.2.11.6 At least the following situations shall be detected as conflicts by the conflict detection function:

Any allocation of a resource to more than one task for a time period exceeding the conflict time threshold,

Any allocation of a not appropriate resource to a task for a time period exceeding the conflict time threshold,

Any forecasted scheduled train mission exceeding the Deviation time threshold.

5.4.2.11.7 The conflict timeframe threshold shall be adjustable by the Dispatcher per area, per resource type and per specific resource.

5.4.2.11.8 The Deviation time threshold shall be adjustable by the Dispatcher per area, per train category and per specific train.

5.4.2.12 **Emergency Stop Management**

5.4.2.12.1 The Dispatcher shall have the possibility to issue an emergency stop message via the Signaling System:

To a train selected by Dispatcher,

To several trains selected by the Dispatcher,

To all trains within a specific station or line,

To all trains within the area of responsibility of Dispatcher/to all lines.

5.4.2.12.2 The emergency messages can be conditional or unconditional. In case of conditional emergency stop, the TMS shall wait for signaling feedback and alert the Dispatcher if conditional emergency stop is rejected by the Signaling system.

5.4.2.12.3 The command of emergency stops shall be done in a safe way, i.e. such a way that the emergency stop command does not cause damage to the people on the train and the train stops in a safe location (not on the bridge, etc..).

5.4.2.13 **ETCS Modes and Authorization**

5.4.2.13.1 The TMS shall, at least, display the following information:

RBC-train link state,

ETCS mode,

Adhesion factor activation (command available for the Dispatcher),

MA status,

TSR status

5.4.2.13.2 The TMS shall be able, at least, to supervise the following train modes:

Trains running in nominal mode (Full Supervision),

On-Sight mode,

Staff Responsible mode,

Shunting mode (SH, in engineering works areas).

Emergency mode (TRIP mode).

Sleeping mode (SL) in case of non-leading cab.

Automatic Driving (AD) mode (GoA2)

Note: For other modes, please refer to *ETCS Technical Specification*.

5.4.2.13.3 The TMS shall also manage "Low Adhesion" areas that alter train braking distance/speed profile in its parameters.

5.4.2.13.4 The Dispatcher shall authorize the Staff Responsible mode (SR) to the driver. This authorization shall be sent to the RBC.

5.4.2.13.5 The TMS shall enable the Dispatcher to authorize the On-Sight mode to the driver if all conditions are satisfied.

5.4.2.13.6 The TMS shall allow the management of the following track conditions:

Adhesion reduced (can be chosen by Dispatcher),

Non-stopping points (information displayed).

5.4.2.14 **Temporary Services**

5.4.2.14.1 The TMS shall have the possibility to establish temporary services, as follows:

Unavailability of a portion of one or both tracks

Unavailability of one or several stations

Works on the tracks

Restrictions or external events of any kind that reduce temporarily the availability and/or the operating conditions of a portion of one or both tracks

5.4.2.14.2 The temporary services, shall be:

Either predetermined scenario

Or manually defined by the operations personnel upon occurrence

5.4.2.14.3 The temporary services can be of:

Prohibition of trains operation into a specific portion of one or both tracks

Prohibition to authorize trains to stop in a specific station

Speed restrictions

Etc....

5.4.2.15 **Automatic Set Up of Operating Restrictions**

5.4.2.15.1 The TMS shall have the possibility to establish automatically speed restrictions, upon receipt of alarms from detectors and sensors:

Wind detectors

Hot box detectors (speed restriction, or route cancelations according to the gravity of the alarm)

Flooding detectors

High Temperature detectors

Broken Rail Detection sensors

5.4.2.15.2 The TMS shall have the possibility to cancel routes automatically and close all the corresponding signals, upon receipt of alarms from detectors and sensors:

- Hot boxes detectors (speed restriction, or route cancelations according to the gravity of the alarm)
- Road Vehicle detectors (from bridges)
- Etc…

5.4.2.15.3 The complete list of safety hazards and HDEWS alarms to consider for automatic reaction shall be defined by the TSCC Contractor during detailed design and safety analysis.

5.4.2.16 Human Machine Interface (HMI)

5.4.2.16.1 A line layout allowing an overview of the whole line or sections under Dispatcher's responsibilities as well as detailed pictures shall be available.

5.4.2.16.2 Detailed pictures shall be available to Dispatcher to facilitate the operation and control functions.

5.4.2.16.3 The design of the Overview and Detailed pictures shall be subject to the specific approval of the Authority.

5.4.2.16.4 The arrangements shall be versatile such that it shall be possible for Dispatchers to call up any display on any screen.

5.4.2.16.5 Overview pictures shall contain information consistent with that required to set main routes and effect train regulation including at least, in correct geographical relationship:

Geographical track layout together with major geographical features including stations, viaducts etc.,

Names of all operational points (stations, stopping points, junctions, crossovers, etc.),

Marker boards together with marker board identity,

Route status indication,

Track section status,

Turnout status and position,

Block occupation and status indications,

Train description for all trains in the area of control,

Timetable deviation,

Temporary speed restriction,

Engineering possession (working area) status,

Shunting area status,

Local operation status,

HDEWS equipment status.

HMI ergonomics studies and human factors shall be studied according to *ISO 11064*.

5.4.2.16.6 The best international practices shall be applied and considered in the relevant design for space utilization.

5.4.2.16.7 The TSCC Contractor shall perform detailed ergonomic studies dealing with the following aspects:

Workstations and furniture,

Best strategy for information display on Dispatcher's workstations,

Working environment and OCC adjustment

Dispatcher workload (Human Factors)

5.4.2.16.8 The results of the studies shall be submitted to the Authority. The comments and suggestions shall be incorporated in the design up to the final approval of ergonomic studies.

5.4.2.16.9 HMI interactions shall be object oriented.

5.4.2.16.10 The HMI interaction shall also be possible via menu-based interaction or typing of commands.

5.4.2.16.11 The following HMI view types shall, at least, be implemented:

Main menu

Specific menu adapted to context (will be detailed during design stage)

Box and list views

Distance-time graph

Schematic track layout

Administration view

Task management view

Infrastructure view for engineering possessions management

Alarms and events dedicated displays

5.4.2.16.12 The Dispatcher shall have the possibility to call HMI object related help and explanatory information for any HMI object directly in relation to that HMI object.

5.4.2.16.13 The information to be displayed in any HMI view shall depend on the TMS role and area of responsibility of the Dispatcher.

5.4.2.16.14 The structure of Main menus and sub-menus shall be adjustable by HMI configuration per HMI view type.

5.4.2.16.15 For every HMI object a specific menu should become available when selecting the HMI object.

5.4.2.16.16 The menu shall be placed in such a way that no vital information is hidden.

5.4.2.16.17 HMI shall ensure that for display of all text, alarms, indications, menu and other written information are displayed in English.

5.4.3 Analysis Tools to Improve and Optimize the Operations

5.4.3.1 Archiving and Reporting

5.4.3.1.1 The TMS shall provide an Archiving function allowing data to be recorded and stored for a period of at least 60 months.

5.4.3.1.2 The Archiving system shall be easily extended.

5.4.3.1.3 It shall be possible to replace a storage unit during the operation with no impact on the operation and Dispatcher's work.

5.4.3.1.4 The recorded data shall allow:

Reports edition,

Secure files transfer via external telecommunication network or media, and

Report printing.

5.4.3.1.5 The TMS shall provide tools to improve and optimize day-to-day operations.

5.4.3.1.6 The TMS shall provide a record function for all relevant data, at least for the following functions:

Playback,

Juridical data recording,

Statistics.

5.4.3.1.7 The Juridical recorded data shall be also available in a separate standalone JRU (Juridical Recording Unit) for a minimum of 90 days, or a longer period if required by the Code of Federal Regulations (CFRs).

5.4.3.2 **Simulator and Training**

5.4.3.2.1 The TMS shall provide a TMS training mode.

5.4.3.2.2 Training mode shall include:

playback of recorded situations,

a simulator with simulated environment including signaling, train movements and TMS interfaces.

5.4.3.2.3 The TMS shall provide a simulation environment to validate any change of the timetable, simulate different scenarios of train delays.

5.4.3.2.4 The TMS shall allow the use of the recorded occurrences in the network to be analyzed and to simulate possible resolution scenarios.

5.4.3.2.5 Within the TMS training system, it shall be possible to carry out several training sessions at the same time.

5.4.3.2.6 A dedicated workstation shall be provided for the Trainer.

5.4.3.2.7 During the training mode playback of recorded situation, it shall be possible to adjust the playback speed.

5.4.3.2.8 The TMS simulator shall be able to allow programmed scenarios.

5.4.3.2.9 The trainer shall have the possibility to use recorded operational situations to define new simulation scenarios using the scenario editor.

5.4.3.2.10 The trainer shall have the possibility to modify existing scenarios using the scenario editor.

5.4.3.2.11 The trainer shall have the possibility to simulate a real timetable within the training mode of the simulator.

5.4.3.2.12 The simulation module shall be further detailed and included during project design.

5.4.4 **Alarms**

5.4.4.1 Alarms general requirements

5.4.4.1.1 Alarms and events shall be displayed and timestamped.

5.4.4.1.2 The TSCC Contractor shall design TMS alarms in accordance with *EN/ISO 62682 standard*.

5.4.4.1.3 All alarm indications shall be flashing when requiring immediate attention and steady if less urgent attention is necessary.

5.4.4.1.4 The alarm attributes shall be at least:

the type: Operational or Synthesis,

the severity: emergency, alert, critical, error, warning, notice, info, debug,

the origin subsystem(s): PIDS, …

the recipient: OCC Supervisor, Dispatcher … They are the responsible users intended to react/respond to the alarm occurrence.

5.4.4.1.5 The TSCC Contractor shall submit alarm management and design to the Authority for approval.

5.4.4.2 Alarm Type

5.4.4.2.1 The following alarm types shall be at least managed by the TMS:

Operational alarms are alarms that potentially impact the service,

Synthetic alarms correspond to the subset of maintenance alarms.

5.4.4.2.2 The qualifications of alarms as Operational and Synthesis shall be done by the TSCC Contractor and submitted to the Authority for approval.

5.4.4.3 Alarm Management

5.4.4.3.1 The TSCC Contractor shall provide an alarm management function including alarm routing for the subsystems interfaced with the TMS.

5.4.4.3.2 Alarm management should be designed in such a way that TMS Dispatcher's workload is never exceeded.

5.4.4.3.3 There shall be an alarms priority ladder to avoid wrong execution of Dispatcher's actions on the TMS system.

5.4.5 User Management (UM)

5.4.5.1 The TMS shall provide a centralized User Right Management function for each area of responsibility. Within the TMS, the user right management function centralizes user management for all functions.

5.4.5.2 The User Right Management function shall be based on the differentiation between TMS roles, areas of responsibilities and the TMS user:

- A TMS role is a specific set of interaction rights and information access rights within TMS, independently from a real TMS user and an area of responsibility.
- An area of responsibility defines the area where a TMS user can execute the assigned TMS role(s).
- A TMS user is a specific Dispatcher, for whom an account has been created. Within the TMS User Right Management function, a specific user must be assigned to one or several TMS roles and to one or several areas of responsibility. When logging into TMS the user takes over the assigned TMS role(s) and area(s) of responsibility.

5.4.5.3 Within User Right Management, the number of managed TMS roles, users, areas of responsibilities and combinations of these shall not be limited.

5.4.5.4 The User Right Management function shall allow predefining some TMS configurations which are used frequently (for example day, night, facilities controlled locally or by OCC, etc.).

5.4.5.5 The Administrator shall have the possibility to define and manage TMS roles independently from specific users and areas of responsibility of the Authority.

5.4.5.6 The Administrator shall have the possibility to define and manage roles at least along the following dimensions:

Availability of functions,
Access to information,
Availability of communication channels,
Availability of HMI types.

5.4.5.7 The Administrator shall be, at least, able to manage a role through the following actions:

Create a role,
Delete a role,
Modify a role,
Replace existing role by another role,
Copy a role,
Suspend a role.

5.4.5.8 The Administrator shall be, at least, able to manage a user and its rights through the following actions:

Create a user,
Delete a user,
Modify a user,
Assign a user to one or several areas of responsibility,
Re-assign a user to one or several areas of responsibility,
Copy an existing user.

5.4.5.9 The User Right Management function shall ensure that only known users can login.

5.4.5.10 All personal data of the users shall be secured against unauthorized access inside TMS and outside TMS.

5.4.5.11 Every user who is logged in to TMS shall be identified unambiguously.

5.4.5.12 Every user who logged in to TMS is only assigned to TMS role(s) defined for that specific user.

5.4.5.13 Every user logged in to TMS shall be able to interact in its assigned area of responsibility and role.

5.4.5.14 The change of users through the Log off from the previous user and the Log in of the succeeding user on the same HMI shall be possible without closing any window and without interruption of operation.

5.4.5.15 Any area and role necessary for operation are covered by users logged in at any time during the operation.

5.4.5.16 An alarm shall be raised in case an area and/or a role is not covered by a user.

5.4.5.17 Area of responsibility means the area that a user/Dispatcher is controlling or operating in the scope of his TMS role when logged in.

5.4.5.18 The Administrator shall have the opportunity to assign areas of responsibility to two or more users performing the same role at the same time.

5.4.5.19 The controlled area is assigned completely at least one user for every role required at any time.

5.4.6 **Video Wall Display (VWD)**

5.4.6.1 The TSCC Contractor shall supply, install, configure, and test a large Video Wall Display (VWD) system in the OCC. Installation, configuration and testing shall be coordinated with the Authority.

5.4.6.2 The VWD system shall be built up by the arrangement of a sufficient number of display screens to be consistent with operational requirements.

5.4.6.3 The VWD system shall also include the necessary equipment (server, video cards, …) to receive, manage and display different video streams from different sources.

5.4.6.4 The VWD system shall be sufficient in size and shall be positioned within the control room so that the displayed details can be clearly seen, and textual details are legible from any of the workstations in the control room.

5.4.6.5 The VWD system shall include dedicated software for the management of the system.

5.4.6.6 The following details shall be on constant display but not limited to:

The track layout of the entire network, including the trainset maintenance facility,

All stabling areas,

The trains running currently on the network and their movements (direction),

The train identification and operating mode of each train,

The routes set,

The track sections with imposed temporary speed restriction,

Engineering possessions,

Temporary speed restrictions,

Traction Power Supply status,

The day of the week and the date in dd-mm-yyyy format,

The accurate time in 24-hour mode and in hh:mm:ss format.

5.4.6.7 The VWD system shall have the ability to display any desired image and the ability to configure the amount and placement of images on the screen. The ability to change shall be flexible and simple.

5.4.6.8 The TMS shall provide input for displaying Main Line panoramic images such that they are independently standalone from TMS. When the dispatcher or the Yard Controller zooms in or zooms out the TMS HMI on their own workstation, the Main Line TMS overview being shown on the panoramic display shall still show the status of the whole Main Line.

5.4.6.9 In addition to the constant display, it shall be possible to display CCTV images on the VWD.

5.4.6.10 The TSCC Contractor shall coordinate with the TCS subsystems for connection rights and video streams access.

5.5 Engineering Possessions Functional Requirements

5.5.1 The TMS shall help the Dispatcher in the management of engineering possession (section(s) of track) to ensure the safety of staff and protection of equipment when working within the engineering possession (Working Area). This function shall allow:

- Automatic setting of engineering possession (planned). These are submitted to the Regulator's approval,
- Engineering possession manually set by the Dispatcher from the OCC or the maintenance staff on-site,
- Definition of the Working Area.

5.5.2 The TSCC Contractor shall propose a solution as described in requirement 4.3.2

5.5.3 The engineering possession function shall enable exclusion from operations of a part of the railway network or a single element of it (i.e. section of the track, any specific turnout).

5.5.4 The timetable management shall allow the planning of the engineering possessions.

5.5.5 The Regulator shall have the possibility to activate and deactivate an engineering possession manually.

5.5.6 In case an engineering possession extends over more than one area of responsibility, TMS shall ensure the correct split of the engineering possessions between these areas of responsibility and transmit it to Interlocking.

5.5.7 The engineering possession management shall be done in a safe way (especially engineering possessions cancellation). The verifications shall be implemented in order to check the validity of orders received. If the Dispatcher chooses the forbidden or invalid possession, the TMS shall block forbidden or incoherent actions, alert the Dispatcher and suggest valid available engineering possessions.

5.5.8 The TSCC Contractor shall describe and implement features enabling safe management of Engineering possessions, in manual mode and in planning mode. Engineering possession management shall be submitted to the Authority for approval.

5.5.9 The TMS shall treat the engineering possession as activated / deactivated only after receiving the status information of the activation / deactivation of the engineering possession from the Signaling System.

5.5.10 The TMS shall report the current status of the engineering possession to the relevant Interfaced systems for further distribution to all relevant stakeholders after receiving the status report of the activation / deactivation of the engineering possession from the Signaling System.

5.5.11 The TMS shall automatically update the train route setting conditions according to activated / deactivated engineering possessions.

5.5.12 In case a catenary switch-on is planned related to an engineering possession, a task request shall be raised to the Power SCADA System or to the TPS Operator to switch-on the catenary after the engineering possession is deactivated.

5.5.13 In case a catenary switch-off is planned related to an engineering possession, the activation of that engineering possession shall only be processed when the catenary switch off is reported by the Power SCADA system or by the TPS Operator to the Dispatcher for the catenary sections concerned.

5.5.14 The TSCC Contractor shall define its solution for the management of engineering possessions and catenary protections, including at least:

- Mapping specification of engineering possession vs catenary protections (and vice versa).
- Specification of the management function for engineering possessions vs catenary protections (including sequence diagrams).

These specifications will be submitted to the Authority for approval.

5.5.15 The commands sent from the TMS to the Signaling System for blocking and unblocking of an engineering possession or for activation and deactivation of a planned engineering possession shall be processed independently in the TMS.

5.5.16 Engineering possessions and catenary protections shall be displayed on TMS HMIs and Time-Distance Graph.

5.6 Traction Power and Electrical Protection Requirements

5.6.1 Even though the control and command of the traction power will be handled by another system (TPS), TMS shall have an interface with the Power SCADA System.

5.6.2 TMS HMI shall give the possibility to the Dispatcher to visualize and acknowledge the energized and non-energized track portions.

5.6.3 The TMS shall prevent a Dispatcher establishing a route, should part or all of this route not be energized. Should the Operator attempt to establish a route along a non-energized portion of track, the TMS shall reject the route and emit a sound and visual alarm.

5.6.4 The establishment of routes along non-energized track portions shall however be possible following double confirmation.

5.7 Local Facilities (LF)

5.7.1 This section provides general information, assumptions, and requirements on TMS principles in the Local Facilities.

5.7.2 The TSCC Contractor shall provide a Local TMS control system for the following facilities: LMF (Light Maintenance Facility), HMF (Heavy Maintenance Facility) and MOWF (Maintenance of Ways Facility). Each facility will have its own dispatcher(s).

5.7.3 Within previous facilities, the TMS control system shall at least allow:

- Display of TCS trackside equipment status and alarms (routes, signals, track sections, axle counter, turnouts, etc.)
- Control of routes,
- Local management of the exchange tracks,
- Shunting train composition activities where needed.

5.7.4 The TSCC Contractor shall provide a Local TMS workstation for each facility.

5.7.5 The Local TMS control system of facilities shall at least interface with:

- Interlocking managing the facilities,
- Main Line TMS.

5.7.6 Depending on the proposed solution for the track configuration and the operational needs, the exchange tracks shall either be managed by the main line TMS or the local TMS control system.

Note: Dedicated tracks separating the main line from facilities shall enable any train movement from the main line to the facilities and from the facilities to the main line.

Those tracks are called “exchange tracks”.

5.7.7 Modification of track configuration and/or operation in facilities operated locally shall not affect the main line TMS configuration and logic.

Note: There shall be segregated data and configuration between main line and the facilities ensuring software integrity / no re-validation and no safety re-demonstration of main line when changing facilities data.

5.8 Performance Requirements

5.8.1 The performance targets and performance requirements of the TMS are closely related to line performance and capacity.

5.8.2 The performance targets definition shall be based on the following assumptions:

- TMS is working in normal operating mode.
- TMS and all its components are working properly.
- Established operating rules and procedures allow the headways defined in the performance targets.
- The performance of the trains operating on the line is compatible with the headways defined by the performance targets.

5.8.3 The TMS shall be able to manage trains running at a maximum operational speed up to 355 km/h (220 mph).

5.8.4 It is required that once a control is initiated by the Regulator that the field equipment receives command and responds to it with minimum delay. The maximum time between activation of a command at the TMS workstation and the interlocking responding shall be lower than 500 ms.

5.8.5 The TMS shall have sufficient processing capacity to process, record and store all necessary information.

5.8.6 The maximum initialization time (from the power on and till the system allowing the Dispatcher to send a command) shall be lower than five (5) minutes.

5.8.7 When a new graphic picture is called up for display on a color screen, the response time from the finish of the entry of the command requesting the display until the conclusion of the drawing of the display, including all data items, must not exceed 4 seconds. Where several pictures are called simultaneously, then the maximum response must not be greater than 8 seconds for five (5) displays. These displays may be either identical or different in content.

5.8.8 Where text Information is called, the screen shall start writing within 2 seconds from the entry of the command and be completed with a screen containing 1000 characters including blanks in not more than 4 seconds. Again, multiple screen requests are possible, and this shall be such that all screens complete writing within 8 seconds.

5.8.9 **Safety requirements**

5.8.10 The TMS system shall comply with the safety requirements defined in the *System Safety Plan*.

5.8.11 The TSCC Contractor shall demonstrate that their proposal is a safe reliable and proven technical solution used on operated HSR program for at least 5 years without any issues.

5.8.12 **RAM Requirements**

5.8.13 The TMS system shall comply with the RAM requirements defined in the Schedule 1.

5.9 Security and Cybersecurity Requirements

5.9.1 The TMS system shall be in full compliance with CHSR cybersecurity controls specified in Technical Specifications for Cybersecurity.

5.9.2 The TMS shall conform to federal, state, and local governing rules, requirements, and regulations.

5.9.3 A System Owner shall be nominated for the TMS, the System Owner shall be accountable for cybersecurity risk ownership and mitigation.

5.9.4 The System Owner shall ensure that appropriate resources are in attendance during threat modelling and risk assessment activities.

5.9.5 User Access control roles defined in the TMS shall be mapped to roles in the centralized directory services, this solution shall be co-engineered with the Cybersecurity Lead and Cybersecurity Services Lead, as defined in the CHSR Cybersecurity Technical Specification and be compliant with the identity, access management, and authentication controls defined in the specification.

5.9.6 Interfaces with other systems shall be authenticated and use secure protocols as defined in the Cybersecurity Specification.

5.9.7 All remote access and inbound or outbound connectivity with systems on the internet or in an IT network (such as a cloud-based EAMS), must comply with the requirements outlined in the Cybersecurity Specification.

6 INTERFACE REQUIREMENTS

6.1 General Requirements

6.1.1 The interfaces are classified as following:

- Third Party interfaces: interfaces between TSCC systems and systems provided by Third Party (excluding CHSR TSCC Contractors)
- External interfaces: interface between TSCC systems and systems provided by CHSR contractors (Civils Packages, Stations contractor, Facilities contractor, Solar PV and BESS contractors)
- Internal Interfaces: Interfaces between systems within the TSCC scope

6.1.2 The TSCC Contractor shall develop design considering the identified Third Parties, External and Internal interfaces to ensure the required functionalities and performance described in this specification.

6.1.3 The TSCC Contractor shall, if necessary, propose any additional interfaces required to ensure the functionalities and performance described in this specification.

6.2 External Interfaces – facilities contractor

6.2.1 The TSCC Contractor shall install all TMS equipment in the OCC and facilities being provided by the facilities contractor.

6.2.2 The TSCC Contractor shall provide to the facilities contractor:

- Equipment dimensions
- Equipment clearances requirements
- Equipment mounting and fixings requirements
- Cable routes/containment requirements
- Equipment loadings
- Installation and maintenance requirements
- Equipment heating loads
- Equipment cooling loads
- Equipment hydraulic requirements

6.2.3 To be provided by facilities contractor to accommodate the TCSS equipment installation and operational/maintenance requirements:

- Room dimensions and layouts
- Room facilities (Plumbing, HVAC, Lighting, Fire Protection Systems, Doors, electricity)
- Room raised floor system
- Delivery access routes.
- Maintenance access routes

6.3 Internal Interfaces

6.3.1 Interface with Power SCADA System

6.3.1.1 The TMS shall interface with the Power SCADA System.

6.3.1.2 This interface shall be realized at a central level through a redundant connection to the Digital Communication Network (DCN).

6.3.1.3 The TMS shall receive from Power SCADA System at least the following status for operational purposes:

Electrical status of catenary sections,

Limited traction power capacity (emergency mode of operation).

Catenary protections requesting engineering possessions to be set by the TMS

6.3.1.4 The TMS shall send to Power SCADA System at least the following information:

Train follow-up information (trains' Ids and location),

The status of engineering possessions when catenary protection for maintenance purposes is requested by Power SCADA System.

6.3.2 Interface with ETCS

6.3.2.1 The interface with the RBC shall be realized at a central level through a redundant connection to the Digital Communication Network (DCN).

6.3.2.2 The interface with RBC shall respect the ERTMS specification Baseline defined in the contract.

6.3.2.3 Note: The SCI-CC interface specification of EULYNX is currently used to interface TMS with CBI; it may also be used to interface RBC to TMS for some specific functions.

6.3.2.4 TMS shall be interfaced with the RBC to exchange the following information:

- Movement Authorities,
- ERTMS Train modes,
- Text message,
- Train running numbers, position and speed,
- RBC equipment status, alarms, and events,
- Temporary Speed Restriction (TSR),
- Low Adhesion Factor activation.

6.3.3 Interface with Interlocking (IXL)

6.3.3.1 The TMS interface with the IXL shall be realized at a central level through a redundant connection to the Digital Communication Network (DCN).

6.3.3.2 The TMS shall enable the control of the 171Miles Early Operating Segment (EOS) of CHSR Merced – Bakersfield.

6.3.3.3 The TMS shall interface by means of EULYNX standard communication protocol (RaSTA) and application layer (SCI-CC) with the IXL system.

6.3.3.4 The EULYNX Baseline Set 4 Release 4 shall be applicable for this interface.

6.3.3.5 The TMS shall be interfaced with the IXL, at least, to exchange the following information:

Route setting,

Trackside equipment monitoring and control (when needed),

IXL and TMS status, alarms, and events,

Temporary Shunting Area (TSA).

6.3.4 Interface with FRMCS

6.3.4.1 TMS shall interface FRMCS to manage the assignment of voice talk group communication according to Area of Responsibility boundaries.

6.3.5 Interface with ICSS

6.3.5.1 The TSCC Contractor shall provide a TMS interface with ICSS.

6.3.5.2 The interface with ICSS shall be realized at central level through a redundant connection to the Digital Communication Network (DCN).

6.3.5.3 ICSS alarms and statuses (only the ones that are necessary for the Dispatcher) shall be routed to the TMS. Depending on the contractor solution, the following alarms may be included:

Rail temperature monitoring system alarms.

Broken rail detection system alarms.

Alarms related to flood monitoring system.

6.3.5.4 The TSCC Contractor shall provide status and alarm list to the Authority for approval.

6.3.6 Interface with DCN

6.3.7 The TMS interface with the Digital Communication Network (DCN) shall be achieved through a redundant connection.

6.3.8 As the Digital Communication Network (DCN) is the main TMS communication link with its interfaces, it shall be designed to offer optimum bandwidth to the TMS.

6.3.9 Interface with Network Timing System (NMS)

6.3.9.1 The TMS interface with the NMS shall be realized at central level through the Digital Communication Network (DCN).

6.3.9.2 The NMS shall provide the TMS with time reference allowing TMS equipment to be synchronized with all TCS systems.

6.3.10 Interface with Public Adress and Customer Information System (PACIS)

6.3.10.1 The TMS shall be interfaced with the PACIS to automatically update traffic information (e.g., arrival times, departure times, destinations, etc.) displayed at platforms and stations).

6.3.10.2 The TMS shall be interfaced with the PAS to automatically update traffic information (e.g., train arrival, train departure, delay, etc.) for audio messages played at platforms and stations.

6.3.11 Interface with EAMS

6.3.11.1 The TMS shall interface with the EAMS.

6.3.11.2 This interface shall be realized at a central level through a redundant connection to the Digital Communication Network (DCN).

6.3.11.3 The TMS shall send the status of engineering possessions, information on incidents and delays.

6.3.11.4 The TMS shall provide static Asset Information and dynamic Asset Information to the EAMS for maintenance activities and asset lifecycle management activities.

6.3.12 Interface with Hazard Detection and Early Warning System (HDEWS)

6.3.12.1 The TMS shall interface with the HDEWS.

6.3.12.2 This interface shall be realized at a central level through a redundant connection to the Digital Communication Network (DCN).

6.3.12.3 Through this interface, the TMS receives operational alarms coming from all the HDEWS detectors.

6.3.12.4 The TMS shall monitor, at least, the following information:

- Connection status to each subsystem,
- HDEWS alarms.

6.3.12.5 **Interface with Low Voltage Power System (LVPS)**

6.3.12.6 The TMS shall be interfaced with LVPS system for power supply.

6.3.12.7 The TMS shall be connected to LVPS as an Emergency Load.

6.3.12.8 In case of nominal power outage, the LVPS shall be able to supply power to The TMS equipment for at least 12 hours.

7 MATERIALS, PRODUCT AND COMPONENTS REQUIREMENTS

7.1 TMS Workstation

7.1.1 The number of Dispatcher's Workstations shall be confirmed by the TSCC Contractor according to the operational needs defined by the Authority.

7.1.2 Workstation position arrangements shall employ fully integrated systems with the minimum number of Operator interface units, displays, Keyboards etc. consistent with efficient operation of all systems and facilities.

7.1.3 Ergonomic studies shall be performed by the TSCC Contractor to organize Dispatcher workstations and HMI. These studies shall be submitted to the Authority for approval.

7.1.4 The operation of the TMS shall enable the signaling system to be controlled and operated in any combination of stations.

7.1.5 The workstation centralized units shall be located in the technical room of OCC to reduce the noise in the control room.

7.2 Servers

7.2.1 The TMS shall be provided with central servers in the OCC configured for Non interrupted service.

7.2.2 The TMS servers' cabinets shall be designed in a way to simplify the maintenance.

7.2.3 The server architecture shall allow centralized architecture of the whole TMS and dimensioning of the system (RAM, telecommunication network etc.) considering the used applications.

7.2.4 The administrator shall be able to request the switch off or reinitialization of the servers of TMS:

- From each workstation,
- Maintenance workstation.

7.2.5 Server's reinitialization shall be imperceptible by the operation, it shall not cause:

- Any display interruption,
- Any communication loose (commands, requests and verification/validation process shall still be continuous without any interruption).

7.3 Redundancy Requirements

7.3.1 The redundancy of the servers located in the OCC shall be of "hot standby" type.

7.3.2 The physical destruction of one server shall not affect the operation of the CHSR line.

7.3.3 All TMS configurations and data shall be retrievable even upon destruction of one server.

7.4 EMC Requirements

7.4.1 The TMS and associated electrical and electronic devices shall be designed to the requirements defined in the *EN 50121-4 standard (Rail Applications - Electromagnetic Compatibility - Part 4: Emission and Immunity of Signalling and Telecommunications apparatus)*.

7.4.2 All equipment shall be provided with its own electromagnetic interference free enclosure where necessary to ensure correct operation and avoid permanent degradation.

8 TOLERANCES

Not applicable to Traffic Management System.

9 SCOPE OF SUPPLY AND DELIVERY

9.1 General Requirements

9.2 General requirements related to the TSCC Contractor Scope of Work are in the Scope of Work.

9.3 Specific Requirements

9.3.1 The TMS scope of supply and delivery shall include (not limited to):

- Servers.
- Workstations/Displays /HMIs.
- Video Wall Display.
- Cabling, connectors, switches/patch panels.
- Racks.
- Software architecture including full specification of protocols used.
- SW licenses.
- Maintenance tools.
- Any necessary supporting structures for TMS.
- To consider test configuration to be delivered:
  - for Authority's testing purposes and
  - for Authority's training purpose
- Any auxiliary elements needed for TMS.
- Training.
- As-built documentation.
- List of parts and components.
- Spare parts.

10 MANUFACTURING

10.1 General Requirements

10.1.1 General manufacturing requirements are defined in the Scope of Work.

11 INSTALLATION AND INTEGRATION

11.1 General Requirements

11.1.1 General installation and integration requirements are defined in the Scope of Work and Schedule 3.

12 TESTING & ACCEPTANCE

12.1 General Requirements

12.1.1 General testing and acceptance requirements are defined in the Scope of Work and Schedule 3.

12.2 Specific Requirements

12.2.1 The TSCC Contractor shall develop a simulated environment to conduct all tests that can be performed using the simulated environment for the equipment and interfaces, before the on-site testing phase. The main goals are as follows:

- Test the TMS functionalities,
- Integrate TMS with TSCC subsystems CBI, RBC, PACIS, etc.,
- Test of the EULYNX interfaces,
- Test operational scenarios,
- Redundancy and robustness test,

12.2.2 The TMS simulation environment(s) shall confirm that the Operational Principles are fully implemented on the prototypes, and this implementation complies with the expected behavior.

12.2.3 The TSCC Contractor shall propose and fulfil a set of functional and operational tests that comply with all the functionality of CHSR signaling principles. These tests scenario shall be accepted by the Authority.

13 SUBMITTALS

13.1 General Requirements

13.1.1 The submittals required for the Interlocking system are defined in the Scope of Work.

14 QUALITY MANAGEMENT

14.1 General Requirements

14.1.1 General quality management requirements are defined in the Agreement and associated Schedules.

15 ADDITIONAL INFORMATION REQUESTED

15.1 General Requirements

15.1.1 In addition to the mandatory requirements outlined in this specification, the Authority reserves the right to request from the TSCC Contractor and related Suppliers, information pertaining to the performance of proposed or supplied elements under similar service conditions, with particular emphasis on railway management aspects which may influence TMS system reliability, availability and maintainability characteristics.

16 LOGISTICS

16.1 General Requirements

16.1.1 General logistics requirements are defined in the Agreement.

APPENDIX A TO EXHIBIT 5(Q) TRAFFIC MANAGEMENT SYSTEM (TMS)