U.S. Department
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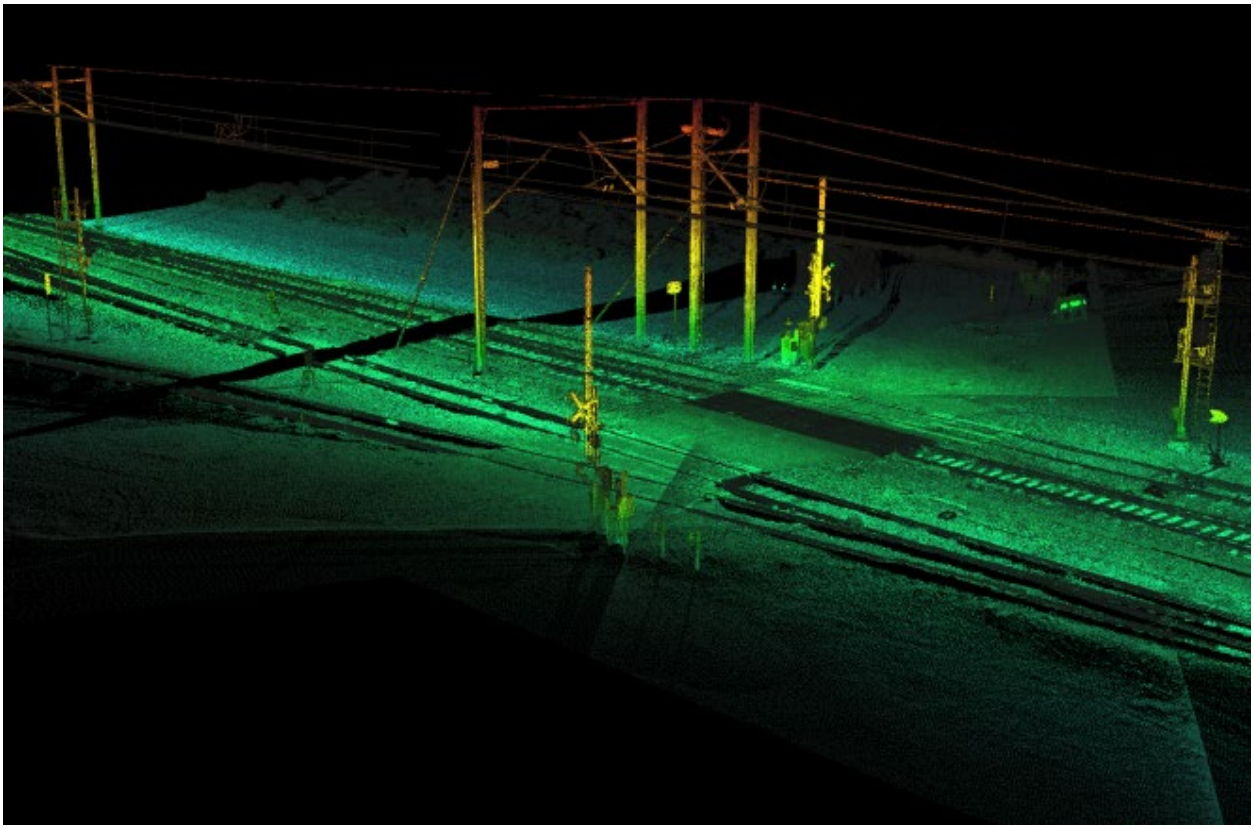
Positive Train Control
Critical Asset Track Database Auditing System (TDAS): Phase II Appendices A Through M



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Positive Train Control (PTC) Track Data Auditing System (TDAS): System Description and Operational Concept v 2.0

System Description and Operational Concept

Version 2.0

October 25th, 2019

REVISION RECORD

VERSION	DESCRIPTION OF CHANGE	DATE
1.0	First distribution of Track Data Auditing System Concept of Operations to FRA.	5/2017
2.0	Update of Concept of Operations in Phase II of Track Data Auditing System program.	10/2019

1. Scope

To function safely and effectively, Positive Train Control (PTC) systems rely on accurate track data, which provides the onboard system with information pertaining to the track profile and location of PTC critical assets. This Concept of Operations (ConOps) document provides the purpose for, and high-level description of the proposed system capabilities, along with standards and best practices for managing auditing of railroad track data for PTC systems that use the Interoperable Train Control (ITC) PTC data model as defined by Association of American Railroads (AAR) Manual of Standard Recommended Practices (MSRP) S-9503. The ConOps highlights major objectives and goals for the system; identifies the system users, primary functions, and high-level architecture; and describes the role the system plays in meeting the railroad industry's PTC track data auditing needs. The definition of and relationships among key system components are discussed along with capabilities and constraints. The document outlines and describes the environment in which the system will operate and the operational scenarios that detail how the system impacts different users under differing conditions.

1.1. System Identifications

Track Data Auditing System (TDAS), Version 1.0.

1.2. Definitions, Acronyms and Abbreviations, Referenced Documents

1.2.1 Definitions

Table A 1. Definitions

Term	Definition
Asset Audit Grouping	Grouping of PTC critical assets during audit data comparison, ranging from individual assets to all assets within track database
Audit	Process of comparing raw audit data against reference data and determining if the data corresponds
Audit Asset Location	Coordinates of a PTC critical asset as determined from the raw audit data
Audit Cycle Duration	Configurable number of days between the audit date and the audit expiration date
Audit Data Collection Date	Collection date of raw audit data
Audit Data Refresh Duration	Configurable number of days between the audit expiration date and the audit data refresh notification date
Audit Data Refresh Notification Date	Date beyond the latest raw audit data collection date at which a notification will be sent indicating new raw audit data is needed

Term	Definition
Audit Date	Collection of date that the raw audit data associated with a completed audit
Audit Expiration Date	Date by which a PTC critical asset must be audited
Audit Management	Process of tracking audits, prioritizing and scheduling audits, generating reports, and providing alerts
Audit Parameters	Parameters related to management of the audit process, which at a minimum, include: Audit Scheduling Parameters, alert and report configurations, asset audit grouping configurations
Audit Priority	Variable assigned to a PTC critical asset identifying its priority to be audited, based on its proximity to its Audit Expiration date
Audit Process	Overall process of collecting raw audit data, comparing raw audit data against reference data, and updating/reporting audit status
Audit Result	Result of the comparison between raw audit data and reference data for an individual PTC critical asset. Set to one of three possible results: **Pass:** Location of a PTC critical asset as obtained from raw audit data is within an established horizontal accuracy along-track of the location specified in the track database and additional reference data Critical attributes of the asset as obtained from raw audit data are determined to match the critical attributes specified in the track database and additional reference data **Exception:** Location of PTC critical asset as obtained from raw audit data and reference data is not within an established distance along-track of the location specified in the track database and additional reference data Critical attributes of the asset are determined not to match the critical attributes specified in the track database and additional reference data **Insufficient data:** location and/or critical attributes of PTC critical asset as obtained from raw audit data could not be reliably verified
Audit Scheduling Parameters	The subset of Audit Parameters related specifically to the scheduling of audit data collection and data comparison, which may include auditing PTC critical asset locations, audit groups, audit durations, audit priority, etc.

Term	Definition
Audit Status	Information pertaining to the raw audit data collection date, audit date, audit data refresh notification date, audit expiration date, and result of last audit
Audit Warning	Alert generated if a PTC critical asset exceeds an established distance along-track from the location stored in the track database
Block Offset	Track referenced coordinate frame with positions relative to the beginning of a block within a track database
Data Collection Parameters	Parameters related to data collection, which may include collection rates, resolution, timing, etc.
Data Collection Location	Locations over which the Data Collection subsystem begins and ends continuous collection of data
Data Comparison Parameters	Parameters related to data comparison, such as those related to error tolerances, identification confidences, etc.
Data Storage Parameters	Parameters related to data storage, such as the amount of raw audit data to retain for PTC critical assets, frequency with which to store new raw audit data, quantity of separate raw audit data collections to store for a single asset
Georeferenced	Referenced to a coordinate frame relative to the earth's surface
Image Data	Data including Light Detection and Ranging (LiDAR) point clouds, video, and still image data
LiDAR	A laser-based, remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light
Machine Vision Sensor	A sensor capable of imaging objects to support machine vision applications
Opportunistic Data Collection	The collection of raw audit data from equipment mounted on vehicles conducting revenue service operations
Positive Train Control (PTC)	A form of train control where train movement authorities and speed limits are transmitted electronically and automatically enforced to prevent violations
PTC Critical Asset	PTC equipment which if destroyed, degraded, relocated, or otherwise rendered unavailable, would affect the safety, reliability or operability of the railroad.
PTC Critical Asset Validation Date	Date on which the location and critical attributes of an individual PTC critical asset was validated

Term	Definition
PTC Critical Asset Survey Point	A reference point on a PTC critical asset used to represent the location and/or bounds of the asset
Raw Audit Data	Data collected during audit process; to be compared against reference data
Reference Data	Data related to a PTC critical asset used as a reference for comparison against when conducting an audit (e.g., data contained within the track database, georeferenced data that has been validated against the track database, or relative location information from a referenced object)
System Update	The process of configuring and modifying system parameters
Targeted Data Collection	Data collection performed as a result of a target order from the Process Management subsystem.
Track Database	Onboard track data file, or subdivision file, targeted for use with the onboard system, as defined in the current version of AAR MSRP K-6, S-9503
Track Database Initialization	The process of adding track databases and corresponding PTC critical asset data to TDAS for the first time
Track Database Update	The modification of track databases and corresponding PTC critical asset data which has already been uploaded to TDAS
Reference Data Validation Date	Date on which reference data was validated

1.2.2 Referenced Documents

1. OpenEI. (n.d.). Retrieved 10 13, 2016, from en.openei.org: en.openei.org/wiki/Definition:Critical_Assets
2. Rail Safety Improvement Act of 2008, Public Law 110-432, Section 102, 122 Stat. 4852 (2008).
3. The Association of American Railroads, Manual of Standards and Recommended Practices (MSRP) K6, S-9501.V1.0, Table of Contents, 2013.
4. Federal Railroad Administration. (2012). Positive Train Control Implementation Status, Issues, and Impacts. Washington DC.
5. The Association of American Railroads, Manual of Standards and Recommended Practices (MSRP) K-6, RP-9511.V1.0, Interoperable Train Control (ITC) Onboard Track Database Field Survey and Validation, 2014.
6. Draft Subdivision File Specification File Format Version, Revision A, August 01, 2016, (assumed to be the next version to be listed in the AAR MSRP K-6, S-9503.V1.0, Interoperable Electronic Train Management System ® [I-ETMS] Subdivision File).

1.3. Document Overview

This contains information about the current PTC track data auditing process and the motivation to enhance this process. This document discusses the user's needs and expectations, and the proposed functionality of the new system.

- Section 1 contains the scope, document overview and purpose, intended audience and a brief overview of the proposed system.
- Section 2 describes the current process, analyzes the user classes, involved personnel, and user interaction.
- Section 3 provides information pertaining to the nature of the current process and the justification for changes.
- Section 4 outlines the proposed system concepts.
- Section 5 illustrates and describes the operational scenarios.

1.4. Intended Audience

The target audience includes personnel involved with the generation, updating, auditing, and maintenance of PTC track data for railroads implementing a PTC system that utilizes the ITC onboard track database file, potential suppliers of the proposed Track Data Auditing System (TDAS) or subsystems and regulatory entities concerned with the accuracy of PTC track data.

1.5. Track Data Auditing System Overview – Concept of Operations Outline

It is essential that track data used by PTC systems be accurate and up to date for the PTC system to function safely and effectively. Although processes exist to document and update PTC track databases following changes made to the track or other PTC critical assets, the potential exists for changes to occur without the track database being updated, for a variety of reasons that are outlined in further detail in Section 3. Auditing of the PTC track databases is necessary to verify that the track data used by the PTC system accurately represents the actual track and PTC critical assets in place. Depending on the approach used, auditing can be a labor-intensive process that can reduce track availability and consume resources. Additionally, the processes are manually managed, which can introduce the potential for irregular audit periods. A system and standards or recommended practices that support a more automated process for scanning the locations and critical attributes of PTC critical assets and auditing PTC track databases could reduce the resource requirements and improve management of the PTC track data auditing processes.

TDAS is a set of defined capabilities and standardized architecture intended to support the ongoing management of PTC track data to meet the requirements of the ITC system. The key objectives of TDAS include flexibility of implementation, supporting increased automation of auditing capabilities, and standardization or definition of best practices for audit management, audit prioritization and scheduling, and record keeping processes.

TDAS is conceived to implement the capabilities defined by industry standards or recommended practices for management of audits and audit data, including audit data collection, audit data storage, audit data comparison, generation of audit reports, and audit prioritization and scheduling. Figure A 1 illustrates the primary subsystems of TDAS and how they interact, as well as a summary of the key logical components.

The Process Management subsystem includes capabilities to manage the overall audit process, produce reports and notifications, store audit data, prioritize and schedule audits, and provide a user interface. The Process Management subsystem interfaces with the railroad back office systems, as well as the TDAS Data Collection and Data Comparison subsystems.

The Data Collection subsystem is envisioned to utilize a variety of machine vision sensors to capture georeferenced, time-stamped data, for PTC critical assets using a data collection approach specified by the individual railroad. Examples of data collection approaches may include use of dedicated data collection vehicles for targeted data collection or use of data collection devices mounted to track vehicles that are capable of collecting data opportunistically throughout normal operations. Georeferenced data initially collected and validated against the track database can be stored as reference data, in addition to the reference data defined within the track database itself.

The raw audit data is processed (i.e., compared against reference data) by the Data Comparison subsystem using one of two potential architectures: distributed, in which data is compared in the field, or centralized, in which data is compared in a central location, such as the railroad back office. In a distributed architecture, the Data Comparison subsystem interfaces directly with the Data Collection subsystem to receive the raw audit data. In a centralized architecture, the Data Comparison subsystem interfaces the Process Management subsystem to receive raw audit data stored in the data storage component. However, regardless of the implementation, all georeferenced data collected in the field will be transferred to and stored in the data storage component of the Process Management subsystem to retain records of raw audit data collected. The comparison of raw audit data against reference data can be done manually or with automated data processing software using a variety of methods, depending on the specific implementation of the system.

Once the comparison of data is complete, the audit results and status are stored in the data storage component of the Process Management subsystem and are used by the audit management component of the Process Management subsystem in tracking the audit status of each PTC critical asset and providing report generation and alerting capabilities, which can be accessed through the Process Management subsystem user interface.

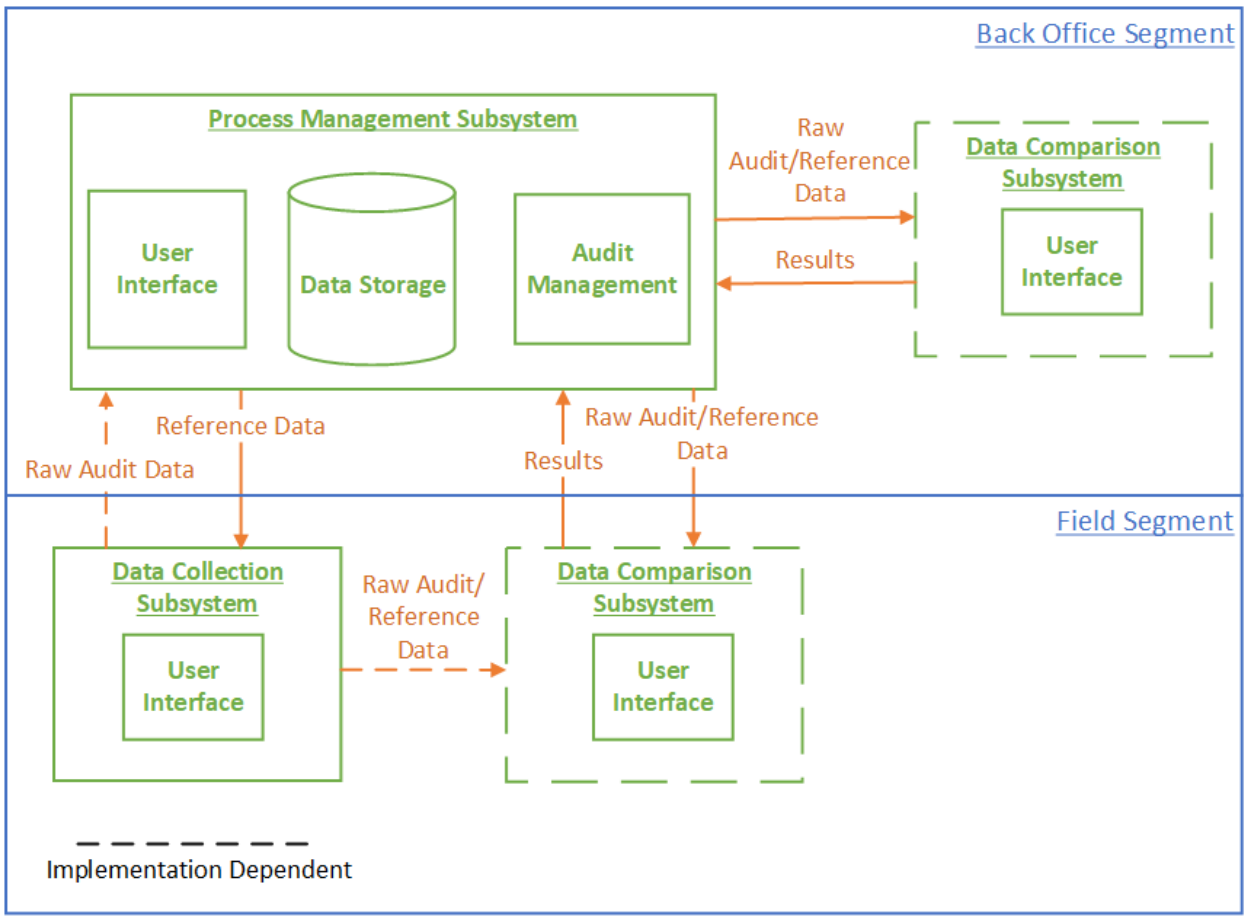

Figure A 1. Track Data Auditing System Architecture

2. Current Process

This section provides background on the ITC PTC system and track database, as well as an overview of the current process for auditing/validating the track database, including definition of the users and their interactions.

2.1 Background

The Rail Safety Improvement Act of 2008 (RSIA '08) requires the implementation of interoperable PTC on rail lines over which intercity passenger or commuter transportation is regularly provided, poisonous or toxic-by-inhalation hazardous materials are transported, and any additional lines identified by the U.S. Secretary of Transportation. PTC is defined within RSIA '08 as a system designed to prevent:

- Train-to-train collisions
- Overspeed derailments
- Unauthorized incursions into established work zones
- Movement of a train through a mainline switch in the improper position

The scope of PTC implementation covers approximately 60,000 miles of the national railroad network and is requiring significant capital expenditure.

To achieve interoperability, the largest Class I freight railroads established the ITC standards, which specify requirements for an interoperable PTC system, including subsystem requirements, interface requirements, human-machine interface (HMI) standards, messaging standards, as well as standards for track data and track database format.

The system defined by the ITC standards is currently designed as an overlay system, providing enforcement of movement authorities and speed limits defined by an underlying method of operation, such as centralized traffic control (CTC) or track warrant control (TWC). In the ITC system, movement authorities and speed limits are transmitted digitally to a computer on board the locomotive. The onboard computer tracks the train speed and location relative to the defined authority and speed limits and calculates the estimated stopping distance of the train on a periodic basis. The system alerts the train crew of any impending speed or authority violations and automatically initiates a penalty brake application if the train is predicted to exceed the limits of its authority or allowable speed.

The onboard computer tracks locomotive position and speed using Global Navigation Satellite System (GNSS), the locomotive tachometer, and a track database defining the characteristics of the track, as well as the locations and critical attributes of all PTC critical assets. Track databases are unique for each rail line; however, to support the ITC system, each railroad must define their track database according to the ITC database format. A PTC track database is a collection of geographical information that specifies track layout information such as track geometry, as well as locations and critical attributes of PTC critical assets. For a PTC system to function properly, the information contained in the track database must accurately represent the characteristics of each asset in the field. The PTC track database file is created in accordance with the ITC

Geographic Information System (GIS) logical model, used by the ITC PTC onboard application system.

The life cycle of a track database consists of four stages: survey, generation, validation, and maintenance.

- Survey – Prior to generating a track database, a survey of the PTC critical assets must be conducted. A number of methods are utilized for this survey including GNSS rovers, GNSS systems mounted on hi-rail vehicles, and airborne and mobile mapping, using Light Detection and Ranging (LiDAR).
- Generation – The track database is generated, per the ITC track data model, using the collected GIS survey data and converted to the ITC standard file format.
- Validation – The track database is validated to ensure the location and critical attributes of each PTC critical asset, defined in the track database, match the characteristics in the field, within the required accuracy.
- Maintenance – Once the track database has been established, ongoing maintenance of the track database is performed, including updating the track database with known changes and auditing the track database to ensure changes are captured.

Validating and maintaining the track database is currently a manual, time consuming process. Track databases are typically not updated until PTC critical assets are visually inspected, surveyed, and documentation is submitted and verified. Locations of PTC critical assets within the track databases can change due to factors such as:

- Construction – Construction activities could include modifying track alignment, modification of road crossings at grade, and the removal or placement of PTC critical assets including switches, signals, mileposts and speed signs.
- Track maintenance – When performing track maintenance, relocation of a PTC critical asset may be required.
- Accidental/unintentional changes – Events such as natural disasters (i.e., wind, tornadoes, floods, etc.), or unintentional changes resulting from track inspection or maintenance may result in asset location changes.
- Theft or vandalism – Theft or vandalism could result in the removal or relocation of an PTC critical asset.

The track database requires regular management and timely updates to ensure safe and efficient rail operations. In addition to the location of PTC critical assets, there are critical attributes associated with the PTC critical assets that may be essential to the ITC system. Asset types and critical attributes that are vital to the PTC system may include those listed in Table A 2.

Table A 2. PTC Critical Assets and Attributes

PTC Critical Assets	Attributes
Track centerline	
Integer mileposts, milepost signs	Sign text (optional)

PTC Critical Assets	Attributes
Signals	Direction of signal Type of signal Signal graphic
Crossings, road crossings at grade	
Switches	Turnout leg Switch orientation
Permanent speed restrictions, speed signs	Sign text (optional)
Track detection circuit limits in non-signaled territory	
Inside switches equipped with switch circuit controllers	
Method of operation signs	Sign text (optional)
Derails	

It may not be necessary to audit every instance of the above assets. For example, derails would only be audited if they act as a clearance point. The specific assets that would be audited will be specified in each PTC track database. Some railroads may opt not to audit the critical attributes identified as 'optional.'

Assets critical to PTC systems must be geolocated to an established horizontal accuracy to provide the precision necessary to safely warn or stop a locomotive. The horizontal requirement is interpreted as an "along track" geolocation of a point on a line perpendicular to the track "alignment," a line which runs from the center of the PTC critical asset to the center of the track, at top of rail track height. The location of a PTC critical asset in the track database is the measured location of a reference point(s) on the PTC critical asset perpendicular to the track centerline. The PTC critical asset is assigned a relative block offset along the centerline of the track instead of the georeferenced coordinates of the PTC critical asset.

2.2 Objectives and Description

The objective of the current audit process is to periodically audit/revalidate track databases to verify the location and attributes of PTC critical assets in the field align with the data contained in the track database. The track database validation and maintenance life cycle stages are important steps in verifying and managing the PTC critical assets within a track database. When validating and maintaining track databases, the railroads verify that the locations of PTC critical assets meet the required accuracy and capture known changes to the track database so that it can be updated. Each railroad adheres to a similar process of revalidating and maintaining track databases. However, they do not currently have a standardized industry system or process in place to accomplish these tasks.

In general, major changes to the track databases (e.g., resulting from large construction projects) are reported to the PTC data group. The changes are then surveyed, and the track database is updated and validated. However, smaller changes run the risk of not being reported in a timely manner. Methodologies are being developed independently by each railroad to manage the

length of time PTC critical assets can go without validation, and how often the assets need to be revalidated. Generally, this task is accomplished by deploying PTC field personnel, e.g., in a hi-rail vehicle, to each PTC critical asset and verify the location meets the required accuracy. If a PTC critical asset is flagged as an exception, the field team reports the exception, and the asset is surveyed and updated in the track database.

2.3 User Classes

There are various groups of users involved in the existing audit process, each with a different role, skill level, job function, and mode of interaction. The specific personnel that carry out these functions may differ between railroads, but Table A 3 shows the defined general user classes for the current audit process:

Table A 3. Existing User Classes

User Class	Functions
Field Survey Team	Survey and provide PTC critical asset and GIS information (i.e., coordinate information) to the appropriate personnel
PTC Track Data Team	Generate, update, and maintain PTC track databases
PTC Field Validation Team	Validate the track database, including revalidation as part of the audit process

2.4 User Interaction

Figure A 2 illustrates the interaction of the current users within the process of auditing/validating PTC critical assets that exist in a track database.

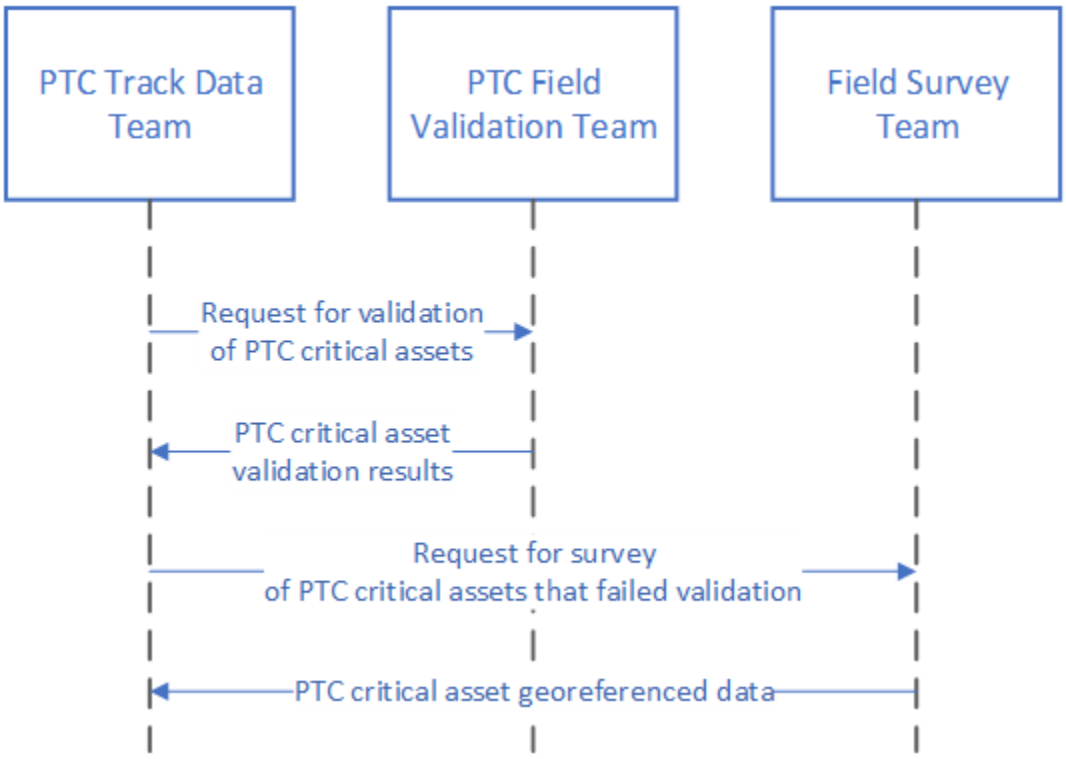

Figure A 2. Current Process – User Interaction

- The PTC track data team requests that the PTC field validation team validate PTC critical assets within a track database.
- The PTC field validation team verifies the location of assets in the track database match the actual field location within the required tolerance.
- The results of the validation process are reported back to the PTC track data team.
- The PTC track data team dispatches a field survey crew to survey locations and critical attributes of any PTC critical asset that is flagged as an exception during the audit/validation process.
- The field survey team provides the PTC track data team with the updated georeferenced information for each PTC critical asset flagged as an exception.
- The PTC track data team updates the track database with the new information for each PTC critical asset.
- The above procedure is repeated until all PTC critical assets within the track database have been validated.

3. Nature and Justification of Changes

The need for enhancement of the current process for PTC track data auditing is discussed within this section. This includes identification of the key limitations of the current process, justification for changes to that process, user expectations for the new system, and finally, desired capabilities of the new system.

3.1 Current Process Limitations

A standard, universal PTC track data audit process is not currently employed by railroads utilizing PTC. Without a standardized process, each railroad must engineer their own solution to ensure that PTC critical assets are audited on a regular basis. The current method for audits may result audits being performed at irregular intervals due to manual audit tracking, scheduling and prioritization.

There is currently not an industry standard method for tracking of audit status and generating audit reports, nor for providing alerts of critical assets that need to be re-audited. The timeliness of notification of critical assets that have been flagged as an exception is dependent on manual communication between the various users.

Depending on the approach used, the current auditing/validation process can be a manual, time consuming process. Auditing PTC critical assets, utilizing current processes, can present a number of challenges:

- Obtaining access to and time on track, while avoiding disruption of train movement and schedules
- Assigning needed resources, including rail vehicles and field crews, to perform the auditing/validation

3.2 Justifications of Changes to Current Process

Based on the limitations of the current process described above, a structured and standardized auditing process and capabilities are needed to:

- Reduce the time and resources required to audit PTC critical assets
- Reduce the potential for human error and inaccuracies in the process
- Manage the audit processes according to established audit requirements
- Provide timely alerts and audit reports
- Create consistency across the industry in terms of audit traceability and reporting, as well as core audit capabilities
- Standardize the core capabilities and interfaces for a TDAS to support current processes and support increased levels of automation

Potential improvements over the current process include:

- Reduced operational impacts
- Improved safety

- Improved system efficiency
- Improved scheduling of audits
- Improved tracking of audit status
- Improved report generation capability
- Standardized audit process

3.3 User Needs/Expectations

The users associated with PTC auditing activities need intelligent auditing system capabilities that:

- Are efficient and create an effective long-term solution
- Integrate with current railroad processes and systems
- Are flexible in terms of level of automation and detailed system behavior associated with each individual implementation
- Regularly assess the audit status of PTC critical assets
- Track PTC critical assets and alert the user of audit exceptions
- Alert the user when audit data collection produces insufficient data to complete an audit
- Alert the user or schedules data collection when a PTC critical asset has not been audited within a specified period of time
- Allow users to access records of raw audit data and audit history
- Are cost-effective
- Can be managed internally or outsourced

3.4 Desired System Capabilities

Establishing a more structured and standardized approach for auditing PTC track data and maintaining track databases will help ensure that the location of PTC critical assets in the field correlate with the information in the track database. The goal is to have each track database audited on a regular basis. New capabilities are required to meet this need. The following is a list of capabilities desired within the new system:

- The system will be capable of collecting and storing raw audit and reference data, through either an automated or manual process, from a variety of data collection sensor types.
- The system will be capable of determining if the location of a PTC critical asset is within a warning distance of the location listed in the track database.
- The system will be capable of determining if the location of a PTC critical asset is within an exception distance of the location listed in the track database.

- The system will be capable of transmitting and receiving data through various methods, including physical transfer of storage devices, and wireless or cellular connections, between the field and back office components.
- The system will include a configurable audit schedule that will identify when each PTC critical asset needs to be audited, and when alerts are provided.
- The system will be capable of prioritizing audits of PTC critical assets that are closer to exceeding the audit expiration dates.
- The system will be able to perform both opportunistic and targeted collection of PTC critical asset data and will provide alerts if data is not collected based on defined dates within the audit schedule.
- The system will be able to generate georeferenced or relative referenced position data for each PTC critical asset.
- The system may be configured to provide alerts to the user for scheduling of targeted raw audit data collection based on a set number of inconsistent or insufficient audit results for a given PTC critical asset. Alternatively, the system may be configured to automatically schedule raw audit data collection for PTC critical assets.
- The system will provide reports and alerts to appropriate personnel/systems within the railroad. The report generation capability of the system will provide information related to audit status, including audit results and audit schedules.
- The system will be able to retract alerts if the conditions for the alert are no longer present. For example, if an updated audit results in a “pass” after an alert has been sent for an audit exception, or if sufficient raw audit data becomes available to complete an audit due to the audit data refresh notification date being reached.

4. Proposed System Concepts

The high-level objectives, approach, scope, and user classes are defined within this section. Further details of the proposed system are provided in subsequent sections.

4.1 Proposed System Objectives and Approach

The objectives of TDAS are:

- To support the defined standards and/or best practices for PTC track data audit management, prioritization, and record keeping processes
- To improve the efficiency of, and reduce the number of resources required for PTC track data auditing
- To allow for incremental increase in the level of automation and be flexible in the method of implementation

The proposed approach is to implement a PTC TDAS that allows for multiple implementations and degrees of automation. The standards or best practices for TDAS will allow the railroads to choose an implementation of TDAS that will best meet their needs. Each railroad will determine the degree of automation that supports their specific implementation which may include the following capabilities:

- Automating the raw audit data collection process
- Automating the audit data comparison process
- Automating the audit scheduling process.
- Implementing the audit data comparison capability in either the back office or in the field

Phased implementation can provide many benefits of TDAS prior to the development of a fully automated system. This approach allows for incremental upgrades or changes to configurations to be made over time. The phased approach will be discussed in further detail in Section 5.

The proposed system will support a process intended to reduce the amount of track time necessary to complete audits by equipping dedicated data collection vehicles or track vehicles with machine vision sensors. Dedicated data collection assets and leveraging of track vehicles already in operation will support reducing delays to operations for audit purposes.

Furthermore, TDAS will establish a common architecture with a flexible, implementation methodology for managing the process of PTC track data auditing. Although TDAS will establish a common architecture to be used by all railroads, it is envisioned that TDAS capabilities may be implemented directly by individual railroads, developed by third party vendors and supplied to the railroads, or by service providers that may offer track data auditing capabilities.

4.2 Scope

The system scope includes the management of the track database auditing process, as discussed in Section 2.1. It is assumed that the track database has previously been built and validated; these capabilities are not intended to be handled by TDAS. The system operates based on the

assumption that PTC critical assets were, at the time of validation, at the locations defined in the track database.

The scope of the TDAS audit process also includes the collection of raw audit data, either manually or automatically. This process also includes the comparison of audit data to reference data, either manually or automatically, to identify discrepancies in PTC critical asset position or critical attributes of assets.

TDAS is intended to be used for the auditing of track database files defined by the ITC data model. It may also be used for auditing of track databases otherwise defined, depending on the specific design and implementation of the system.

An investigation of audit exceptions and PTC critical asset maintenance are outside the scope of the system. TDAS is not initially intended to identify the location of missing PTC critical assets, or PTC critical assets not identified in the track database, but these capabilities may be included in future iterations.

The intent is to provide report generation, alerting, and prioritization capabilities. These capabilities can be used to make decisions related to audit scheduling and support more efficient processes for handling exceptions including cases where audit data is insufficient, or audits are not being performed at an adequate frequency.

4.3 User Classes/Involved Personnel

The user classes for the proposed system are similar to the user classes defined for the current process, although the roles of the personnel, job functions, and modes of interaction will change with the new system capabilities. The titles of the user classes and the responsibilities of each class can be adapted to each railroad's needs and organizational structure, but the intent here is to define the basic functional user categories. Table A 4 defines the following user classes for the proposed system:

Table A 4. TDAS User Classes

User	Functions
PTC Track Data Team	• Determine configurable parameters of TDAS • Oversee TDAS and the auditing process • Oversee track database initialization and track database updates • Manage alerts, audit exceptions, and other anomalies
Audit Data Collection Team	• Manage collection of raw audit data • Oversee transfer of raw audit data to the data storage component • Schedule targeted collection of raw audit data, as appropriate/required • Perform raw audit data collection (if/when raw audit data collection is done manually)

User	Functions
Audit Comparison Team	• Compare raw audit data against reference data (if processing of data is done manually in the back office) • Oversee processing of raw audit data against reference data (if processing of data is done automatically)
TDAS Maintenance Team	• Implement updates or changes to TDAS • Perform TDAS routine maintenance • Troubleshoot TDAS failures

5. System Architecture, Design, and Operational Scenarios

This section describes the architecture of TDAS and how the capabilities can be implemented based on the specific operational scenario(s).

5.1 System Architecture

Figure A 3 illustrates the system architecture from Figure A 1 with the inclusion of subsystem capabilities and their associated logical components. The system is comprised of a Process Management subsystem, Data Collection subsystem, and Data Comparison subsystem. The Process Management subsystem facilitates data storage, the user interface, and audit management capabilities. The Data Collection subsystem facilitates collection of raw audit data. The Data Comparison subsystem facilitates comparison of raw audit data to reference data.

The Process Management subsystem includes an interface to both the Data Collection and Data comparison subsystems. Reference data is passed from the Process Management subsystem to both Data Comparison and Data Collection subsystems. Raw audit data collected by the Data Collection subsystem can be passed to the Data Comparison subsystem directly via an interface between those subsystems, or routed through the Process Management subsystem, depending on implementation. Results from audit data comparison are passed from the Data Comparison subsystem to the Process Management subsystem.

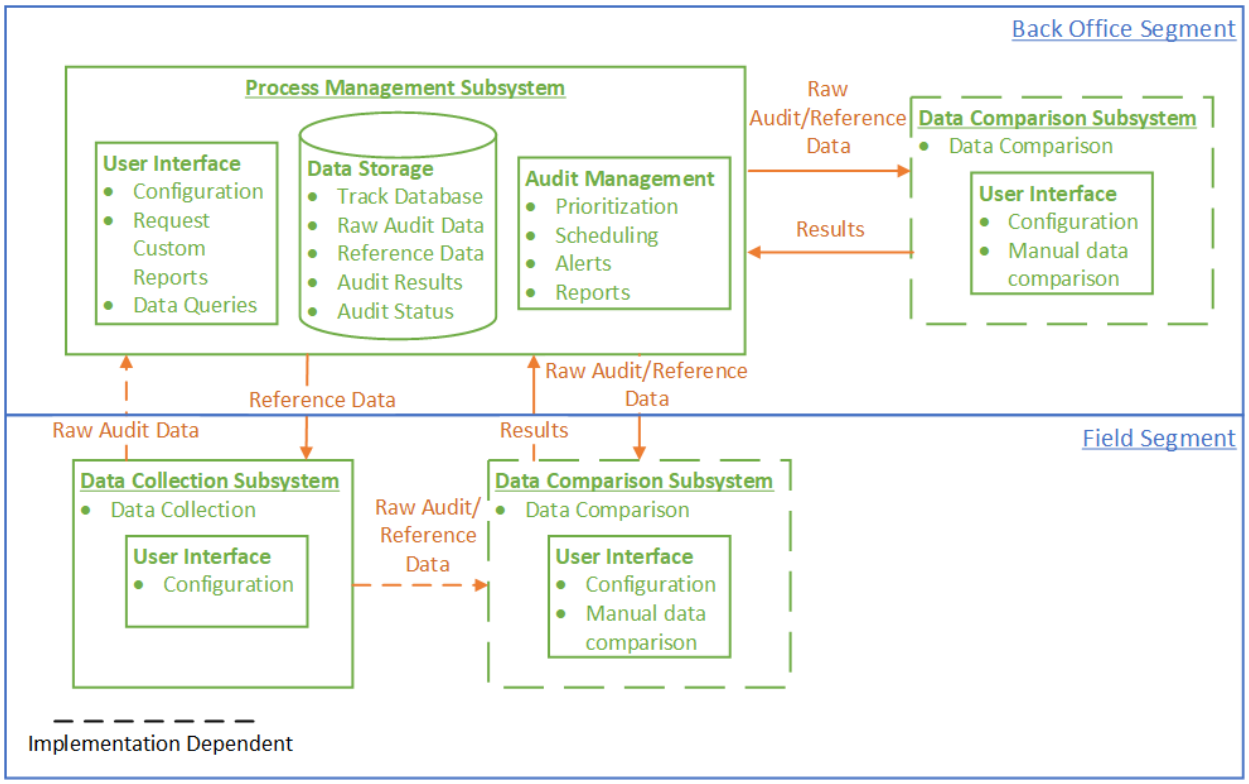

Figure A 3. TDAS Architecture – System Capabilities

5.1.1 Process Management Subsystem

The Process Management subsystem is the backbone of TDAS. It includes capabilities to:

- Manage prioritization and scheduling of audits
- Manage all data stored and transferred between the back office and TDAS subsystems, including:
  - Track databases
  - Raw audit data
  - Reference data
  - Audit results
  - Audit status
- Allow configuration of audit management capabilities and audit parameters by users
- Provide alerts and reports
- Provide custom reports and data upon user request

To support the raw audit data collection process, the Process Management subsystem provides the required reference data to the Data Collection subsystem and facilitates transfer of audit data from the Data Collection subsystem into the data storage component. The Process Management subsystem also provides the raw audit data and associated reference data to the Data Comparison subsystem to support the data comparison process and saves the audit results to the data storage component. Upon completion of data comparison, as expiration dates are reached, and for other configurable events, the Process Management subsystem produces reports and alerts related to audit results and status information and stores this data internally in the data storage component.

The Process Management subsystem can be implemented as:

- A standalone entity which interfaces with the other TDAS subsystems and the railroad back office.
- A component of the railroad back office which augments existing back office functionality and leverages existing capabilities.

5.1.2 Data Collection Subsystem

The Data Collection subsystem includes the capabilities to:

- Collect raw audit data
- Support user configuration of data collection parameters

The audit data collection team or automated Data Collection subsystem is provided with the reference data, from the Process Management subsystem, necessary to identify the PTC critical assets and verify their location and critical attributes. This reference data may include:

- Data contained in the track database file:
  - PTC critical asset location (i.e., coordinates, station/offset)
  - PTC critical asset type
  - PTC data source ID

- Image data
- Offsets from PTC critical asset survey points which cannot be measured directly
- Geographical boundaries containing the targeted PTC critical assets

The audit data collection team or automated Data Collection subsystem collects and provides raw georeferenced PTC critical asset image data that is date and time stamped to the Process Management subsystem or Data Comparison subsystem, depending on implementation.

The collection of raw audit data can be a manual or automated process. The automated Data Collection subsystem may be implemented on several different vehicle types, including locomotives, track inspection vehicles, and dedicated track database data collection vehicles, or include manual data collection via field survey crews. Operation of the automated Data Collection subsystem will require little or no input from users and can be operated by minimally trained railroad personnel.

Data Collection subsystems performing opportunistic data collection using vehicles that are conducting revenue service operations cannot rely on movement direction or speed of the vehicle. Due to variation in placement, size, orientation, and configuration of PTC critical assets, the Data Collection subsystem must be capable of collecting data from a large enough radius around the collection vehicle, and from multiple vantage points, and at speeds up to those required by the railroad. The PTC critical assets may be located between rails, perpendicular to rail, on adjacent tracks, or span across multiple tracks above rail. Furthermore, some PTC critical assets and their critical attributes are directionally specific.

Data capture can be performed continuously over a specified region, or only occur when collecting data for a specific asset, depending on how the Data Collection subsystem is implemented. Some examples of when these options may be utilized include:

- In the case of targeted data collection for an entire subdivision, continuously upon initialization of audit
- Intermittently in the case of targeted data collection, asset by asset (e.g., with a field survey crew)
- Continuously over targeted regions in the case of opportunistic data collection

Data required by the Data Collection subsystem prior to performing an audit will be dependent on whether data is collected intermittently at the assets themselves, or continuously over a region. The data collection subsystem will require location information for individual assets or the boundaries of the regions it will collect data within. In addition to data collected for determination of asset location, image data must also be collected to identify and compare critical attributes of assets to reference data. These images may be utilized for archival of the condition and unique identification of an asset.

The capabilities of the data comparison subsystem and specific requirements of railroads will drive the requirements for the data collection subsystem capabilities with regard to data quality. Images must be sufficient to identify assets, locate them within required tolerances, and perform comparison of critical attributes to reference data. Data quality will be affected by, and drive the following parameters:

- Data collection subsystem resolution

- Vehicle speed
- Accuracy requirements of the railroad
- Data compression and storage methods

5.1.3 Data Comparison Subsystem

The Data Comparison subsystem evaluates raw audit data against reference data and determines if an asset passes an audit or is flagged as an exception. The Data Comparison subsystem includes capabilities to:

- Compare audit asset location to the location in the track database
- Compare asset attributes to reference data
- Support user configuration data comparison parameter

Data passed to the Data Comparison subsystem by the Process Management subsystem or Data Collection subsystem is utilized by the Data Comparison subsystem to evaluate asset locations. Using raw audit data collected by the Data Collection subsystem and reference data provided by the Process Management subsystem or Data Collection subsystem, the Data Comparison subsystem determines if the location of PTC critical assets falls within the along-track distances defined by the established configurable warning and exception distances and passes these results to the Process Management subsystem.

Data comparison can be a manual or automated process and can be performed in the field or back office. The automated Data Comparison subsystem will be capable of identifying assets from raw data, determining georeferenced locations of those assets, and comparing this information to the reference data to determine if an asset is within the specified distances along the track centerline. Additionally, the automated Data Comparison subsystem will be capable of identifying discrepancies between critical attributes contained in raw audit data when compared to reference data. Manual data comparison will require the same data as an automated system but include a user interface to allow users to perform the same processes manually.

Data comparison can be performed either in the back office or in the field. The data required for each method is the same, but if the comparison is performed in the field, the reference data must be transferred to the location where the data comparison is performed, whereas if the comparison is performed in the back office, the raw audit data must be transferred.

5.2 System Design Considerations

The following subsections detail TDAS capabilities, processes managed, and standards and/or best practices which TDAS adheres to. Also discussed are interactions with railroad subsystems and information communicated to/from TDAS and railroad subsystems.

5.2.1 Allocated Error Budget

The sum of the error contributions allocated to individual subsystems must not exceed a specified total allocated system accuracy. Contingent on vendor selection, final allocations may be adjusted by each individual railroad to meet the specified total allocated system error budget. Up to 0.43 meters of error may be inherent in a validated track database file, leaving the

remainder of the error budget available to allocate to the Data Collection and Data Comparison subsystems of TDAS.

5.2.2 Audit Dates, Prioritization, and Scheduling

TDAS capabilities include prioritizing audits and audit data collection and determining when audits need to be scheduled. TDAS may also schedule audits and audit data collection, and allocate resources depending on the specific implementation.

5.2.2.1 Audit Date, Audit Expiration Date, and Data Comparison Prioritization

The audit date and audit expiration date are set for each asset every time that asset is audited. When the raw audit data is compared against the reference data and it is confirmed that the asset location information in the track database matches the asset location in the raw audit data within the required accuracy (considering the allocated error budget), the audit date and audit expiration date are set as follows:

- The audit date is set to the raw audit data collection date (i.e., the date the raw audit data that was used in the data comparison was collected).
- The audit expiration date is set based on the audit cycle duration. The audit cycle duration is a configurable number of days the audit is valid for (i.e., the number of days past the audit date within which the asset must be audited again).
- The audit cycle duration may vary based on PTC critical asset characteristics such as asset type and the territory in which the assets are located.

If data comparison is performed in the back office, the Process Management subsystem continuously updates the audit priority of each asset, based on temporal proximity of an asset to its audit expiration date.

The Data Comparison subsystem can perform audits based on multiple variables, including:

- Asset audit priority
- Data format (e.g., data may be provided to the Data Comparison subsystem as individual assets, groups of assets, or subdivisions)
- User configuration of audit parameters related to prioritization and asset audit grouping of a dataset

As audit datasets are provided to the Data Comparison subsystem, they are sorted based on priority of assets within the datasets. Configurable parameters will allow users to control the subsystem's behavior when a dataset containing higher priority asset(s) is provided to the subsystem while in the process of auditing another.

The use of opportunistic data collection may result in frequent generation of audit data for assets regularly passed by vehicles equipped with audit data collection hardware. Configurable parameters will allow users to determine how much data is stored for individual assets or asset audit groupings to avoid producing an excessive amount of redundant data sets, but still allow the option to store extra datasets for some redundancy to support the Data Comparison subsystem. Additionally, to the system may be configurable in terms of how frequently the Data

Comparison subsystem performs audits on datasets, if audit data is provided for assets that are not approaching their audit expiration date.

If raw audit data for an asset has been identified as insufficient for data comparison, the Process Management subsystem will send an alert. As each asset is audited, the Process Management subsystem updates the priorities and the process continues in this manner. If the audit expiration date is reached and raw audit data has not been collected, the system will send an alert. If the audit expiration date is reached and an audit has not been performed, the system will send an alert. If an audited asset is identified to be greater than the configurable distance outside of its identified location in the reference data, the system will send a corresponding alert. The system may be configurable such that, if an audit results in an audit exception, the Process Management subsystem will support various levels of alerts. The alert levels may be based upon PTC critical asset types and territory (e.g., depending on territory, an audit exception identified for a signal may have a higher priority than that of a milepost sign).

If data comparison is performed in the field, the data comparison prioritization may not apply, as the data comparison for each asset can be performed at the time of data collection.

5.2.2.2 Audit Data Refresh Notification Dates and Data Collection Alerting

In addition to the audit date and audit expiration date described above, TDAS will also maintain an audit data refresh notification date to help ensure that raw audit data is available to perform an audit prior to the audit expiration date. The audit data refresh notification date is the date beyond the latest raw audit data collection date at which an alert will be sent indicating new raw audit data is needed. When raw audit data has not been collected prior to the audit refresh notification date, the system will send an alert.

In the case that raw audit data has been collected, but has not yet been processed in an audit, it is possible to have the audit data refresh notification date after the audit expiration date, as shown in Figure A 4.

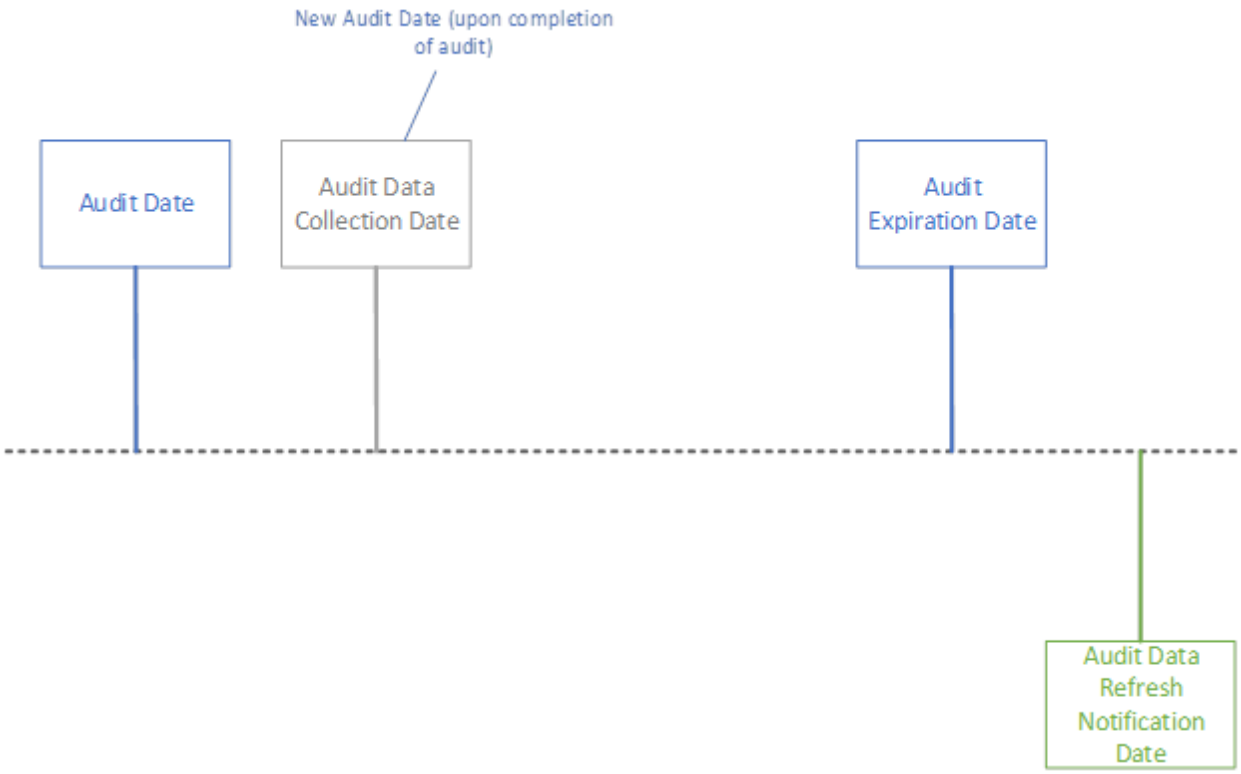

Figure A 4. Audit Data Refresh Notification Date Following New Raw Audit Data Collection

It is assumed that the data comparison will be prioritized for the raw audit data collected so that the data is compared prior to reaching the audit expiration date.

5.2.2.3 Audit Data Collection Scheduling

Asset prioritization will determine when audit data collection should be performed for individual assets, groups of assets, or subdivisions. The system may schedule data collection at various levels of granularity, ranging from individual assets, groups, or subdivisions, depending on the needs of the railroad and the specific implementation of the system. The Process Management subsystem will utilize asset priorities, asset locations, and location of data collection vehicles, to manage data collection assignment. The primary goal of the scheduling capability is to manage utilization of audit assets to keep PTC track databases audited according to the defined audit frequency. This is accomplished by focusing on reduction of distance traveled by audit vehicles, while simultaneously preventing audit dates from being missed.

The system will also allow scheduling of a data collection assignment at a different level, such as when a single asset from a subdivision has been assigned for a collection, but it is preferred to collect the entire subdivision.

5.2.3 Alerts and Reports

TDAS will produce alerts and reports and send them when certain audit related events occur. Alerts may be automatically sent for scheduling, missing audit data and failed audits. Reports

may be configurable by users and may include user defined summaries of data in the system, such as audit results and alerts.

5.2.3.1 Alerts

The purpose of the alerting capability is to provide immediate notification to the users of the system. The information that can be provided in alerts may include:

- Audit exceptions
- Insufficient audit data
- Audit data refresh notification date reached
- Audit expiration date reached
- Asset location close to exceeding limit

The Process Management subsystem will include an interface for users to receive alerts. If an alert has been generated or an audit exception is identified, TDAS will have the capability of accepting additional information provided to the system pertaining to the PTC critical asset's audit status and storing this information with the audit results. Additional information may include:

- The date set for targeted raw audit data collection of a PTC critical asset for which an alert was generated as a result of insufficient or audit exception results, or for a PTC critical asset reaching its audit data refresh notification date or audit expiration date.
- Updates regarding errors identified in baseline data
- Details concerning PTC critical assets removed from track databases

This allows for supplemental information that is not provided by TDAS to be stored, which may be used for purposes such as:

- Providing explanation for audit alert retractions
- Providing explanation for audit status changes
- Documenting errors in the audit process

5.2.3.2 Retraction of Alerts

After an alert has been generated, TDAS will be capable of retracting the alert, for cases when the alert is no longer valid, such as the following cases:

- An alert has been sent indicating raw audit data for an asset is insufficient, and new data becomes available that is not identified as insufficient
- An audit exception alert has been sent for an asset, and an updated audit results in a pass
- An audit exception alert has been sent for an asset, and an updated track database is provided which rectifies the exception
- An audit exception alert has been sent for an asset, and the exception is overridden by the user

- An alert has been sent for an asset's audit data refresh notification date and new raw audit data becomes available for the asset
- An alert has been sent for an asset's audit data refresh notification date and an updated track database has been provided to the system
- An alert has been sent indicating an expired audit, and an updated track database has been provided to the system

5.2.3.3 Reports

The purpose of the report generation capability is to provide audit summary information to users of the system. Information that may be reported with TDAS includes:

- Audit results
- Audit status
- Audit alerts

Reports can be structured to contain multiple levels of detail. Summary information about individual subdivisions allow for a quick overview of the audit results and status of a subdivision, while more detail can be included for individual assets within the subdivision.

The Process Management subsystem will allow the user to develop custom reports using data available from the system, configure what data is reported, and schedule reports. Reports can be configured to be automatically delivered on a regular basis, such as a monthly report for audit status.

5.2.4 Data Storage

The role of the data storage component is to store all data associated with auditing the PTC track data. The Process Management subsystem will provide a user interface that will allow a user to access all information related to PTC track data auditing (i.e., audit status). Depending on the implementation of the system, the data storage component may need to accommodate a large amount of data for each PTC critical asset. TDAS data may need to be retained for traceability of previous audits and to review audit exceptions.

5.2.5 Audit Initialization and Updates

Initialization is the process of adding track databases and corresponding asset data to TDAS for the first time, while updating is the modification of track databases and corresponding asset data which has already been uploaded to TDAS.

The Process Management subsystem may include an interface to allow the user to obtain a list of all current track databases available and identifying each track database to be audited by TDAS. Upon initialization of a track database for audit, the Process Management subsystem will be provided the selected track database files and parse data relevant to the assets selected for audit.

Depending on the implementation, TDAS may periodically contact the back office to verify it is utilizing the most up-to-date track database. If a more current track database version is identified, the updated version of the track database may be compared against the previous track database to identify changes, and update assets that have changed.

TDAS may use the track database as the only reference data or it may use additional reference data (e.g., image reference data), along with the track database for auditing purposes, depending on the implementation. The track database is required reference data for each PTC critical asset and critical attributes contained in the track database. Additional reference data may be uploaded during initialization or at other times, for example when the track database is updated.

Note: Additional reference data must also be validated prior to being used as TDAS reference data. Unvalidated reference data could lead to false exceptions, as TDAS cannot identify the difference between an audit exception and bad reference data.

5.3 Operational Scenarios

One of the key objectives of TDAS is to allow for flexibility in implementation. The architecture is modular and allows for future expansion and implementation in several configurations. This section outlines how the subsystems and capabilities of the system can be implemented in the field or back office and considers whether the data collection and processing are manual or automated.

Figure A 5 illustrates the proposed implementation options (operational scenarios) for TDAS. Each of the operational scenarios defines a potential implementation option in terms of (a) functions performed in the field versus the back office, as well as (b) functions performed manually versus those that are automated. The operational scenarios demonstrate the various implementation options, and also help to outline the potential evolution of TDAS technology, as capabilities are advanced. The following subsection discusses the elements common to all operational scenarios, and describes each individual operational scenario in further detail.

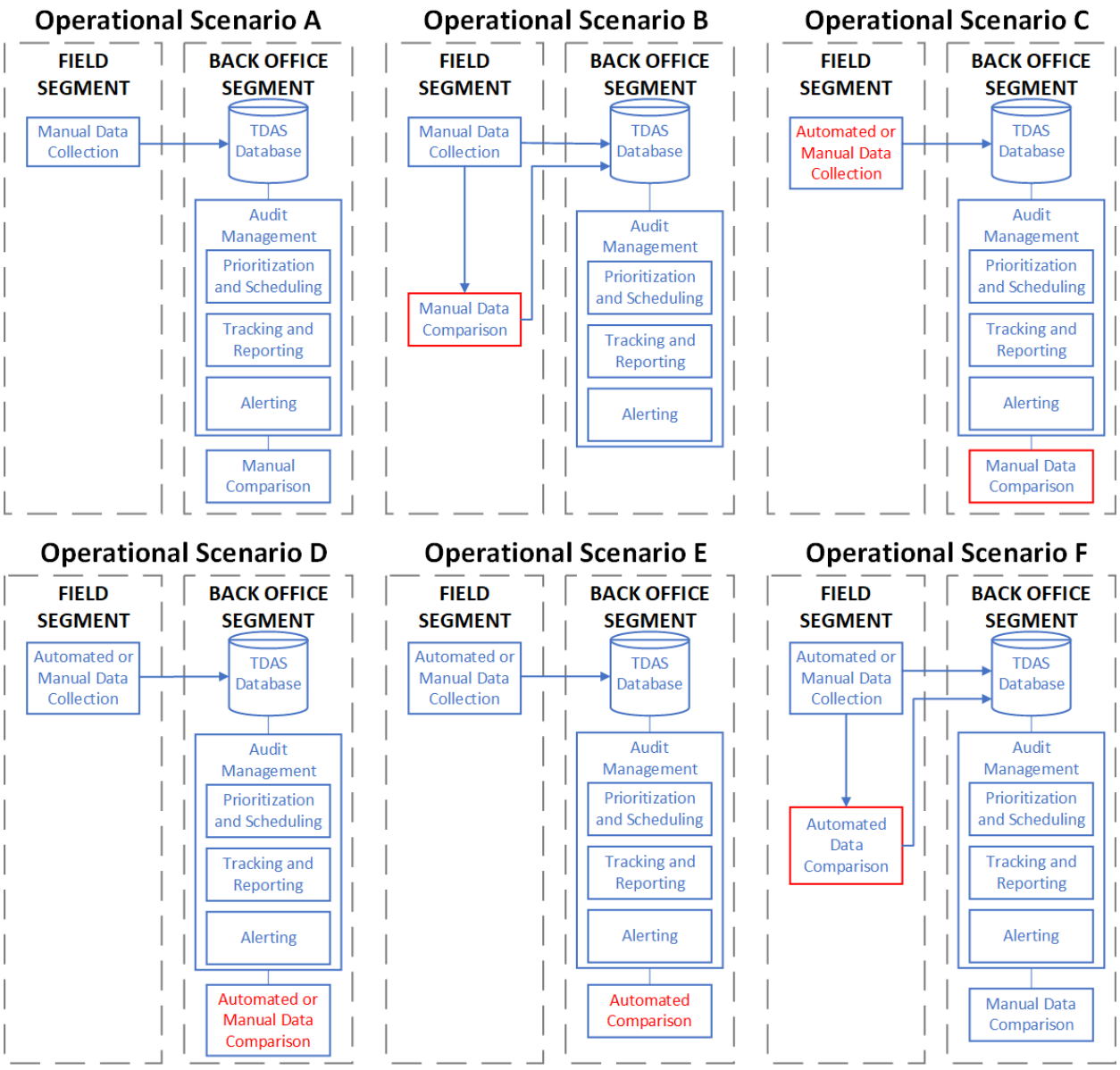

Figure A 5. Operational Scenarios

The primary TDAS capabilities in each of the following operational scenarios are:

- Data collection
- Data comparison
- Data storage
- Audit prioritization and scheduling
- Audit tracking and report generation
- Alerting

The method utilized to collect and compare data varies based on the operational scenario. There are multiple approaches that can be implemented in the field to collect raw audit data, as well as comparing the data either in the field or back office.

5.3.1 Operational Scenario A

In Operational Scenario A, as shown in Figure A 6, data collection and comparison are manual processes requiring personnel to gather the raw audit data in the field and compare the raw audit data against reference data in the back office.

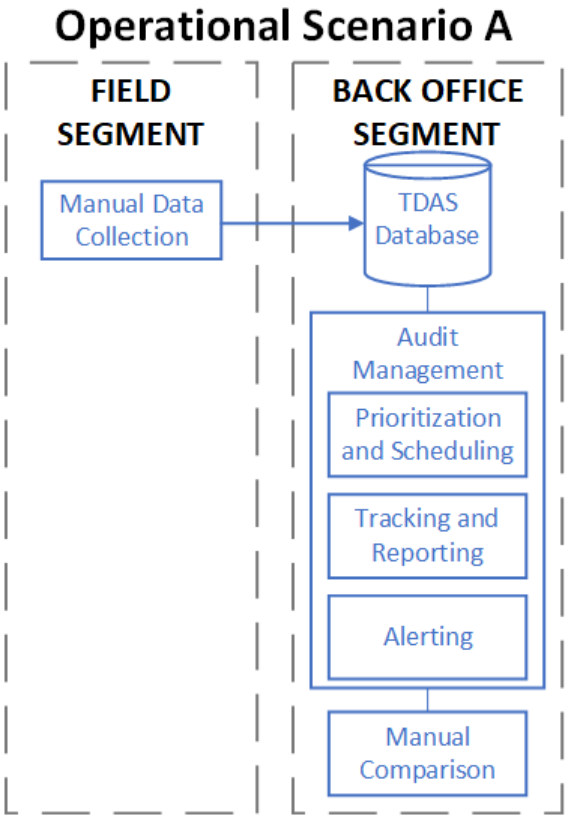

Figure A 6. Operational Scenario A

In Operational Scenario A, the audit data collection team uses the coordinates in the reference data provided to locate each PTC critical asset. The audit data collection team collects the raw audit data necessary to complete the comparison of audit data in the back office. The audit data collection team transfers the raw audit data to the Process Management subsystem via the user interface, so that the comparison of raw audit data against reference data can be completed in the back office using a manual process.

5.3.2 Operational Scenario B

In Operational Scenario B, as shown in Figure A 7, data collection and comparison are manual processes requiring personnel to gather the raw audit data and compare the raw audit data against reference data, but in difference to Operational Scenario A, the data comparison is performed in the field.

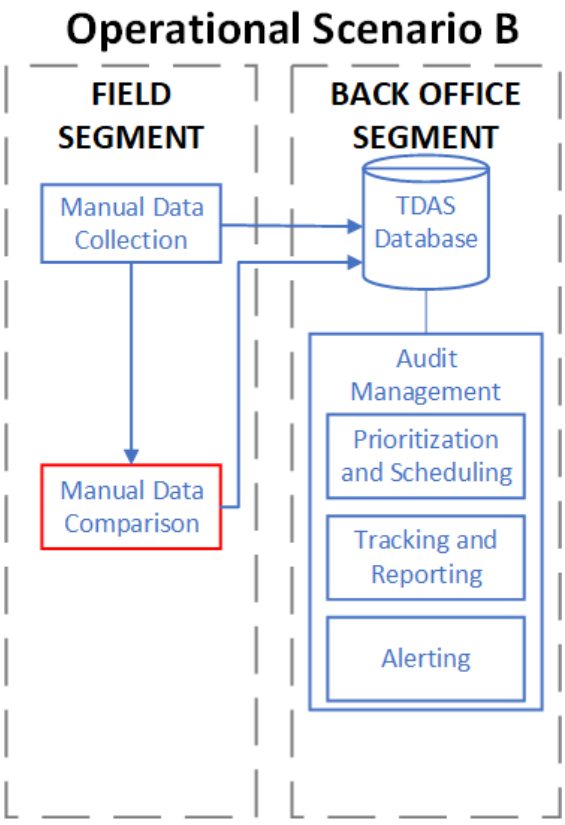

Figure A 7. Operational Scenario B

In Operational Scenario B, the audit data collection team uses the reference data provided to locate each PTC critical asset. The audit data collection team collects the raw audit data necessary to complete the comparison of raw audit data against reference data, using a manual process, in the field. Once the comparison of data is complete, the audit data collection team transfers the raw audit data, reference data, and audit results via the user interface to the Process Management subsystem, where the data is stored in TDAS database. Data collection/comparison is prioritized based on the temporal proximity to the audit data refresh notification date.

5.3.3 Operational Scenario C

In Operational Scenario C, as shown in Figure A 8, raw audit data is collected opportunistically during normal operation. This is accomplished through an automated process utilizing any of a variety of machine vision sensors to capture georeferenced data of PTC critical assets. Manual data collection may be used on an exception basis when automated data collection is prohibitive or not possible. The raw audit data is manually compared against reference data in the back office.

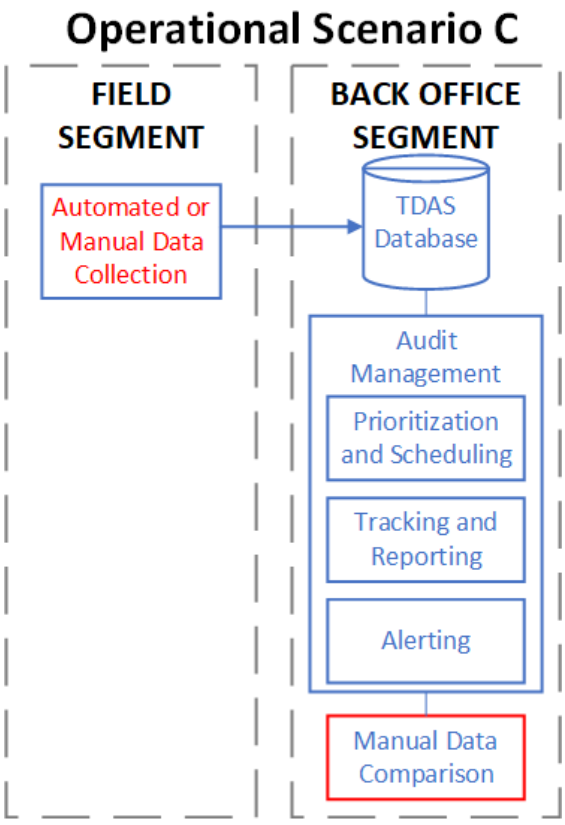

Figure A 8. Operational Scenario C

In Operational Scenario C, using the coordinates in the reference data provided, the Data Collection subsystem collects the raw audit data necessary to complete the comparison of audit data in the back office as it passes each PTC critical asset location. The data collection system transfers the raw audit data through an interface to the Process Management subsystem, either in real time or as otherwise configured, so that the comparison of raw audit data against reference data can be completed in the back office using a manual process.

5.3.4 Operational Scenario D

In Operational Scenario D, as shown in Figure A 9, raw audit data is collected opportunistically during normal operation. This is accomplished through an automated process utilizing machine vision sensors to capture georeferenced data of PTC critical assets. Manual data collection may be used on an exception basis when automated data collection is prohibitive or not possible. The raw audit data will be compared against reference data in the back office through a combination of manual and automated processes.

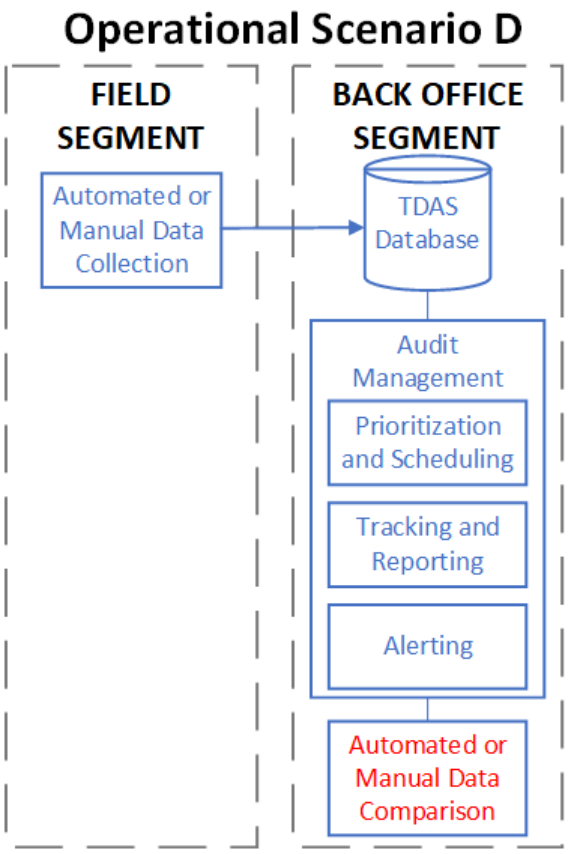

Figure A 9. Operational Scenario D

In Operational Scenario D, using the coordinates in the reference data provided, the Data Collection subsystem collects the raw audit data necessary to complete the comparison of audit data in the back office as it passes each PTC critical asset location. The Data Collection subsystem transfers the raw audit data through an interface to the Process Management subsystem, either in real time or as otherwise configured, so that the comparison of raw audit data against reference data can be completed in the back office using a manual or automated process. In Operational Scenario D, automated data processing software is utilized to compare the raw audit data against reference data for certain PTC critical assets, while others are still compared manually.

This operational scenario may be used in cases where certain assets are difficult to compare automatically, or the cost of developing the processing software for these assets might limit the number of assets that can be practically compared automatically. This operational scenario may also be a transitional scenario, in which automated data comparison has been validated for certain assets, but not yet for others. It is assumed that manual comparison will be required to confirm the audit results from the automated processing software until sufficient confidence in the software is achieved. Periodic manual comparison, for quality assurance, may also be necessary to verify the automated processing software continues to meet the data comparison requirements throughout the life of the system.

5.3.5 Operational Scenario E

In Operational Scenario E, as shown in Figure A 10, raw audit data is collected opportunistically during normal operation. This is accomplished through an automated process utilizing machine vision sensors to capture georeferenced data of PTC critical assets. Manual data collection may be used on an exception basis when automated data collection is prohibitive or not possible. The raw audit data is automatically compared against reference data in the back office.

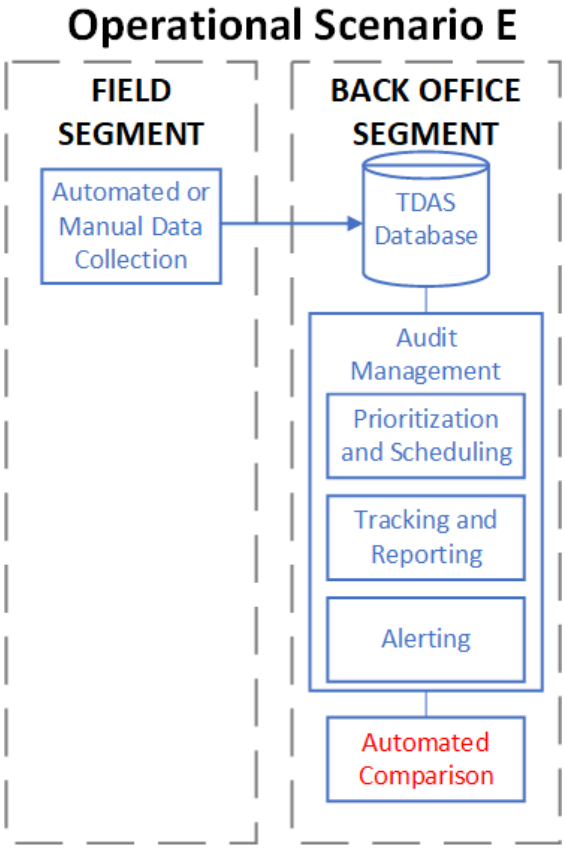

Figure A 10. Operational Scenario E

In Operational Scenario E, using the coordinates in the reference data provided, the Data Collection subsystem collects the raw audit data necessary to complete the comparison of audit data in the back office as it passes each PTC critical asset location. The Data Collection subsystem transfers the raw audit data through an interface to the Process Management subsystem, either in real time or as configured, so that the comparison of raw audit data against reference data can be completed in the back office using an automated process. In Operational Scenario E, the automated process utilizes data processing software to perform the comparison for all PTC critical assets. It is assumed that manual comparison will be required to confirm the audit results from the automated processing software until sufficient confidence in the software is achieved. Periodic manual comparison, for quality assurance, may also be necessary to verify the automated processing software continues to meet the data comparison requirements throughout the life of the system.

5.3.6 Operational Scenario F

In Operational Scenario F, as shown in Figure A 11, raw audit data is collected opportunistically during normal operation. This is accomplished through an automated process utilizing machine vision sensors to capture georeferenced data of PTC critical assets. Manual data collection may be used on an exception basis when automated data collection is prohibitive or not possible. The raw audit data is automatically compared against reference data in the field.

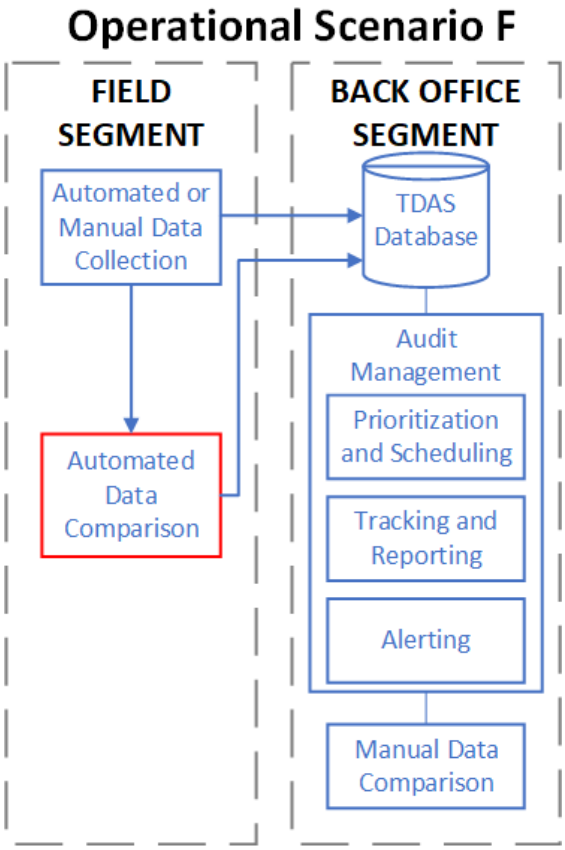

Figure A 11. Operational Scenario F

In Operational Scenario F, using the coordinates in the reference data provided, the Data Collection subsystem collects the raw audit data necessary to complete the comparison of audit data as it passes each PTC critical asset location. Comparison of raw audit data against reference data is performed, using an automated process, in the field. This has the potential to eliminate, or potentially reduce, the need for transfer of the full raw dataset to perform the audit, increasing the time in which an audit can be completed. In Operational Scenario F, audit results can be determined and communicated to the Process Manager subsystem in advance of the data set being transferred for storage purposes. The automated process utilizes data processing software for all PTC critical assets. Once the comparison of data is complete, the Data Collection subsystem transfers the raw audit data, reference data, and audit results through an interface to the Process Management subsystem, either real time or as configured. Once the transfer of data has been completed, the Process Management subsystem stores the data in the TDAS database.

5.4 Phase Implementation Approach

The system architecture and operational scenarios are designed to allow for a phased implementation approach that incrementally increases the level of automation of the auditing capabilities in each development/implementation phase. One of the fundamental concepts behind the architecture of the system is to provide flexibility in implementation and support incremental improvement through phased development and implementation.

By implementing Operational Scenario A or B, the railroad can establish a standardized process for data collection, data comparison, audit status tracking, alerting, and prioritization, using the standard architecture of TDAS, without incurring the additional cost of automated data collection and comparison capabilities.

If Operational Scenario A or B is initially executed, a railroad can incrementally implement automated data collection in the field as described in Operational Scenario C. This would allow the railroad to distribute the cost of implementing automated data collection across their entire network by allowing them to purchase and mount the automated data collection system to a data collection vehicle over an extended period of time rather than acquiring the equipment and cost at one time.

If a railroad decides to implement the system as described in Operational Scenario D, to automatically compare data, data comparison algorithms can be incrementally developed, validated, and implemented in TDAS, beginning with a single PTC critical asset type. Once the data comparison algorithm for this particular PTC critical asset is completed and validated, the development of algorithms for other PTC critical assets could continue. PTC critical assets may need to be prioritized when developing the automated routines, e.g., based on which PTC critical asset types are the most prevalent and thus require the most manual effort for comparison, or based on which PTC critical assets are more difficult or time-consuming for manual comparison. It may not provide sufficient value to develop automated data comparison capabilities for some assets, for example those that may only exist in a few locations.

The process of incrementally developing and implementing automated data comparison algorithms may continue until a railroad develops a fully automated data comparison process as described in Operational Scenario E. Operational Scenario E would reduce the manual effort needed to complete the comparison capability of the system thus reduce system operating costs and the potential for human error.

In Operational Scenarios C, D, and E, the data comparison capability is performed in the back office, which means that the comparison of data may not take place immediately. In Operational Scenario F, data comparison for each PTC critical asset can be performed at the time of data collection, allowing report generation for audit status and results to occur in a timelier manner. As a result, there may be desire for a railroad to continue to advance the capabilities to perform the automated data comparison capability in the field.

Appendix B.
Positive Train Control (PTC)Track Data Auditing System (TDAS): System Requirements Specification v 2.0

System Requirements Specification

Version 2.0

January 15th, 2020

REVISION RECORD

VERSION	DESCRIPTION OF CHANGE	DATE
1.0	First distribution of Track Data Auditing System - System Requirements to FRA.	5/2017
2.0	Update of System Requirements in Phase II of Track Data Auditing System program.	1/2020

1. Definitions

Table B 1. Definitions

Term	Definition
Asset Audit Grouping	Grouping of PTC critical assets during audit data comparison, ranging from individual assets to all assets within a track database
Audit	Process of comparing raw audit data against reference data and determining if the data corresponds
Audit Asset Location	Coordinates of a PTC critical asset as determined from the raw audit data
Audit Cycle Duration	Configurable number of days between the audit date and the audit expiration date
Audit Data Collection Date	Date raw audit data was collected
Audit Data Refresh Duration	Configurable number of days between the audit expiration date and the audit data refresh notification date
Audit Data Refresh Notification Date	Date beyond the latest raw audit data collection date at which a notification will be sent indicating new raw audit data is needed
Audit Date	Date that the raw audit data associated with a completed audit was collected
Audit Expiration Date	Date by which a PTC critical asset must be audited
Audit Management	Process of tracking audits, prioritizing and scheduling audits, generating reports, and providing alerts
Audit Parameters	Parameters related to management of the audit process, which at a minimum, include: Audit Scheduling Parameters, alert and report configurations, asset audit grouping configurations
Audit Priority	Variable assigned to a PTC critical asset identifying its priority to be audited, based on its proximity to its Audit Expiration date
Audit Process	Overall process of collecting raw audit data, comparing raw audit data against reference data, and updating/reporting audit status

Term	Definition

Audit Result	Result of the comparison between raw audit data and reference data for an individual PTC critical asset. Set to one of three possible results:
	• Pass:
	  ○ location of a PTC critical asset as obtained from raw audit data is within an established horizontal accuracy along-track of the location specified in the track database and additional reference data, and
	  ○ critical attributes of the asset as obtained from raw audit data are determined to match the critical attributes specified in the track database and additional reference data
	• Exception:
	  ○ location of PTC critical asset as obtained from raw audit data and reference data is not within an established distance along-track of the location specified in the track database and additional reference data, or
	  ○ critical attributes of the asset are determined not to match the critical attributes specified in the track database and additional reference data
	• Insufficient data: location and/or critical attributes of PTC critical asset as obtained from raw audit data could not be reliably verified

Audit Scheduling Parameters	The subset of Audit Parameters related specifically to the scheduling of audit data collection and data comparison, which may include: auditing PTC critical asset locations, audit groups, audit durations, Audit Priority, etc.
Audit Status	Information pertaining to the raw audit data collection date, audit date, audit data refresh notification date, audit expiration date, and result of last audit
Audit Warning	Alert generated if a PTC critical asset exceeds an established distance along-track from the location stored in the track database
Block Offset	Track referenced coordinate frame with positions relative to the beginning of a block within a track database
Data Collection Parameters	Parameters related to data collection, which may include: collection rates, resolution, timing, etc.
Data Collection Location	Locations over which the Data Collection subsystem begins and ends continuous collection of data

Term	Definition
Data Comparison Parameters	Parameters related to data comparison, such as those related to error tolerances, identification confidences, etc.
Data Storage Parameters	Parameters related to data storage, such as the amount of raw audit data to retain for PTC critical assets, frequency with which to store new raw audit data, quantity of separate raw audit data collections to store for a single asset
Georeferenced	Referenced to a coordinate frame relative to the earth's surface
Image Data	Data including LiDAR point clouds, video, and still image data
LiDAR	A laser-based, remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light.
Machine Vision Sensor	A sensor capable of imaging objects to support machine vision applications.
Opportunistic Data Collection	The collection of raw audit data from equipment mounted on vehicles conducting revenue service operations.
Positive Train Control (PTC)	A form of train control where train movement authorities and speed limits are transmitted electronically and automatically enforced to prevent violations.
PTC Critical Asset	PTC equipment which if destroyed, degraded, relocated, or otherwise rendered unavailable, would affect the safety, reliability or operability of the railroad
PTC Critical Asset Validation Date	Date on which the location and critical attributes of an individual PTC critical asset was validated
PTC Critical Asset Survey Point	A reference point on a PTC critical asset used to represent the location and/or bounds of the asset
Raw Audit Data	Data collected during audit process; to be compared against reference data
Reference Data	Data related to a PTC critical asset used as a reference for comparison against when conducting an audit (e.g., data contained within the track database, georeferenced data that has been validated against the track database, or relative location information from a referenced object).
System Update	The process of configuring and modifying system parameters

Term	Definition
Targeted Data Collection	Data collection performed as a result of a target order from the Process Management subsystem
Track Database	Onboard track data file, or subdivision file, targeted for use with the onboard system, as defined in the current version of AAR MSRP K-6, S-9503
Track Database Initialization	The process of adding track databases and corresponding PTC critical asset data to TDAS for the first time.
Track Database Update	The modification of track databases and corresponding PTC critical asset data which has already been uploaded to TDAS.
Reference Data Validation Date	Date on which reference data was validated

1.1 Introduction

This document specifies the system-level requirements for a Track Data Auditing System (TDAS) for auditing of PTC critical asset data specified by the Interoperable Train Control (ITC) data model standards.

PTC is a train control system designed to provide warning and enforcement of the operational limits (e.g., authority and speed limits) of trains. In the United States, an interoperable PTC system is being established and implemented based on ITC standards, which specify requirements for an interoperable PTC system.

In the ITC-specified system, the onboard computer tracks its position and speed using a Global Positioning System (GPS)-based location determination system and the locomotive tachometer, and a database defining the characteristics of the track and the locations and critical attributes of all PTC critical assets. Track databases are unique for each rail line; however, to support the ITC system, each railroad must define their track database according to the ITC-specified data format. A PTC track database is a collection of geographical information that specifies track layout information such as track geometry and locations and critical attributes of PTC critical assets. The PTC track database file is created in accordance with the ITC Geographic Information System (GIS) logical model, used by the ITC PTC onboard application.

For a PTC system to function properly, the information provided in the track database must accurately represent the characteristics of the PTC critical assets in the field. Validating and maintaining the track database is currently a manual, time consuming process. TDAS has been defined as a concept for enhancing the efficiency and effectiveness of the PTC track data auditing process, through a standardized architecture and incremental increases in the level of automation.

TDAS utilizes a common architecture with a standardized, yet flexible, implementation methodology for managing the process of PTC track data auditing. The system adheres to standards and best practices for the PTC track data audit management, prioritization, scheduling,

and record keeping processes, while maintaining the flexibility needed to support multiple implementation options and migration strategies. TDAS is intended to improve the efficiency of and reduce the level of resources required for PTC track data auditing, through progressively enhanced levels of automation in the auditing process.

1.2 Purpose

This document specifies the high-level requirements for TDAS, including:

- System architecture:
  - Required subsystems
  - Subsystem interfaces
- Audit management requirements:
  - Data management requirements
  - Audit prioritization and scheduling requirements
- Data collection requirements
- Data comparison requirements

1.3 Scope

TDAS is a comprehensive PTC track data auditing tool that includes:

- Audit management
- Audit prioritization
- Audit scheduling
- Audit reporting
- Archiving of raw audit data and reference data
- Collection of raw audit data
- Processing of raw audit data against reference data
- And Alerting of audit exceptions

Investigation of audit exceptions and PTC critical asset maintenance are outside the scope of the system. TDAS is not conceived to identify the location of missing PTC critical assets, in other locations, or PTC critical assets not identified in the track database.

1.4 Applicable Documents

The following documents are applicable to the extent they are referenced in the text of this specification:

- PTC Critical Asset Track Data Auditing System: System Description and Operational Concept

2. General Overview

TDAS is designed to manage the track data auditing functions for a railway network, including performing data collection, data storage, data comparison, reporting, audit prioritization, and audit scheduling functions.

The Process Management subsystem includes capabilities to manage the overall audit process, produce reports and notifications, store audit data, prioritize and schedule audits, and provide a user interface. The Process Management subsystem interfaces the TDAS Data Collection and Data Comparison subsystems and may also interface railroad back office systems.

The Data Collection subsystem captures georeferenced, time-stamped data for PTC critical assets. The raw audit data collected by the Data Collection subsystem is processed (i.e., compared against reference data) by the Data Comparison subsystem using one of two potential architectures:

- Distributed, in which data is compared in the field, or
- Centralized, in which data is compared in a central location, such as the railroad back office

In a distributed architecture, the Data Comparison subsystem interfaces directly with the Data Collection subsystem to receive the raw audit data. In a centralized architecture, the Data Comparison subsystem interfaces the Process Management subsystem to receive raw audit data stored in the data storage component. Regardless of the implementation, all georeferenced data collected in the field is transferred to and stored in the data storage component of the Process Management subsystem to retain records of raw audit data collected. The comparison of raw audit data against reference data can be done manually or with automated data processing software using a variety of methods, depending on the specific implementation of the system.

Once the comparison of data is complete, the audit results and status are stored in the data storage component of the Process Management subsystem. The audit management component of the Process Management subsystem uses this data for tracking the audit status of each PTC critical asset and providing report generation and alerting capabilities, which can be accessed through the Process Management subsystem user interface.

3. User Classes

Table B 2. TDAS User Classes

User	Functions
PTC Track Data Team	1. Determine configurable parameters of TDAS 2. Oversee TDAS and the auditing process 3. Oversee track database initialization and track database updates 4. Manage alerts, audit exceptions, and other anomalies
Audit Data Collection Team	1. Manage collection of raw audit data 2. Oversee transfer of raw audit data to the data storage component 3. Schedule targeted collection of raw audit data, as appropriate/required 4. Perform raw audit data collection (if/when raw audit data collection is done manually)
Audit Comparison Team	1. Compare raw audit data against reference data (if processing of data is done manually in the back office) 2. Oversee processing of raw audit data against reference data (if processing of data is done automatically)
TDAS Maintenance Team	1. Implement updates or changes to TDAS 2. Perform TDAS routine maintenance 3. Troubleshoot TDAS failures

4. System Requirements

4.1 System Architecture Requirements

SYS, 4.1-1 – Process Management Subsystem

The system shall include a Process Management subsystem.

Note: System architecture is illustrated in Figure B 1. The figure provides an overview of the main subsystems and their core logical components, along with how these subsystems interface.

SYS, 4.1-2 – Data Collection Subsystem
The system shall include a Data Collection subsystem.

SYS, 4.1-3 – Data Comparison Subsystem
The system shall include a Data Comparison subsystem.

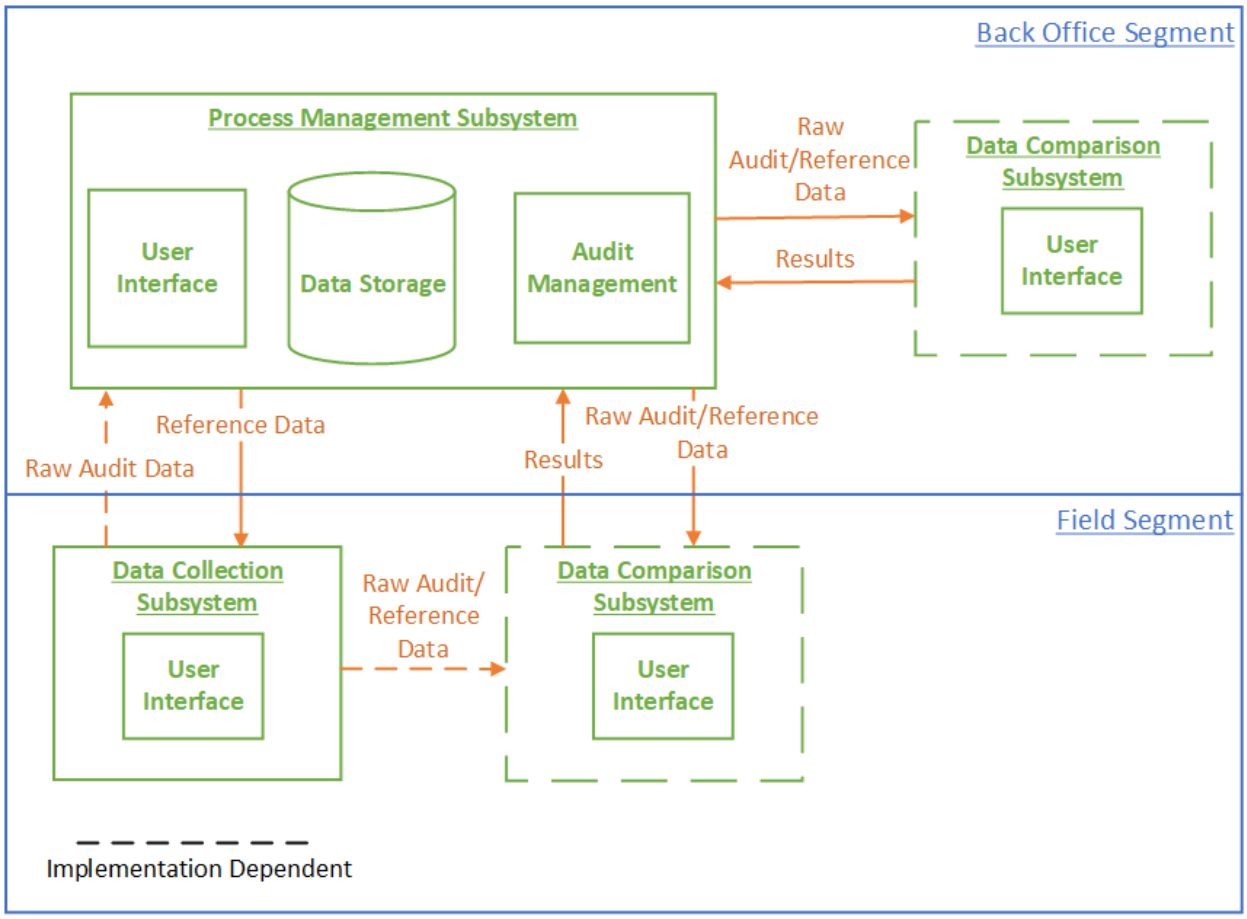

Figure B 1. Track Data Auditing System Architecture

SYS, 4.1-4 – Raw Audit Data Transfer: Data Collection Subsystem to Process Management Subsystem
The system shall support the transfer of raw audit data from the Data Collection subsystem to the Process Management subsystem.

SYS, 4.1-5 – Raw Audit Data Transfer: Data Collection Subsystem to Data Comparison Subsystem

The system shall support transfer of raw audit data from the Data Collection subsystem to the Data Comparison subsystem.

SYS, 4.1-6 – Raw Audit Data Transfer: Process Management Subsystem to Data Comparison Subsystem
The system shall support transfer of raw audit data from the Process Management subsystem to the Data Comparison subsystem.

SYS, 4.1-7 – Reference Data Transfer: Process Management Subsystem to Data Comparison Subsystem
The system shall support transfer of reference data from the Process Management subsystem to the Data Comparison subsystem.

SYS, 4.1-8 – Reference Data Transfer: Process Management Subsystem to Data Collection Subsystem
The system shall support the transfer of reference data from the Process Management subsystem to the Data Collection subsystem.

SYS, 4.1-9 – Reference Data Transfer: Data Collection Subsystem to Data Collection Subsystem
The system shall support the transfer of reference data from the Process Management subsystem to the Data Collection subsystem.

SYS, 4.1-10 – Audit Management User Interface: Audit Parameter Configuration
The system shall provide an interface for PTC Track Data Team users to configure audit parameters.

SYS, 4.1-11 – Audit Management User Interface: Audit Result Override
The system shall provide an interface for PTC Track Data Team users to override audit results for a PTC critical asset(s) selected for audit management.

SYS, 4.1-12 – Data Comparison User Interface: Manual Data Comparison
The system shall provide an interface to perform manual data comparison.

SYS, 4.1-13 – Alert Interface
The system shall provide an interface to send alerts.

SYS, 4.1-14 – Audit Management User Interface: Alert Configuration
The system shall provide an interface for PTC Track Data Team users to configure alerts.

SYS, 4.1-15 – Report Interface
The system shall provide an interface to send reports.

SYS, 4.1-16 – Audit Management User Interface: Report Configuration
The system shall provide an interface for PTC Track Data Team users to configure reports.

SYS, 4.1-17 – Data Collection User Interface: Configuration
The system shall provide an interface for Audit Data Collection Team users to configure data collection parameters.

SYS, 4.1-18 – Data Collection User Interface: Audit Data Download
The system shall provide an interface to support download of audit data.

SYS, 4.1-19 – Audit Management User Interface: Audit Data Upload

The system shall provide an interface to support upload of audit data.

SYS, 4.1-20 – Data Comparison User Interface: Configuration
The system shall provide an interface for Audit Comparison Team users to configure data comparison parameters.

4.2 Audit Management Requirements

SYS, 4.2-1 – PTC Critical Asset Audit Management
The system shall audit PTC critical assets and their critical attributes.

Note: Table B 3 identifies PTC critical assets and attributes specified for audit management.

Table B 3. PTC Critical Assets and Attributes

PTC Critical Assets	Attributes
Track centerline	
Integer mileposts, milepost signs	Sign text (optional)
Signals	Direction of signal Type of signal Signal graphic
Crossings, road crossings at grade	
Switches	Turnout leg Switch orientation
Permanent speed restrictions, speed signs	Sign text (optional)
Track detection circuit limits in non-signaled territory	
Inside switches equipped with switch circuit controllers	
Method of operation signs	Sign text (optional)
Derails	

SYS, 4.2-3 – Audit Parameter Configuration
The system shall support user configuration of audit parameters.

Note: Audit parameters are parameters related to management of the audit process, which at a minimum, include audit durations, alert and report configurations, and PTC critical asset audit grouping configurations.

4.2.1 Tracking and Reporting Requirements

SYS, 4.2.1-1 – PTC Critical Asset Audit Data Storage
The system shall store the following data for all specified PTC critical assets selected for audit management:

- Raw audit data
- Reference data
- Audit results
- Audit status

SYS, 4.2.1-2 – Track Database Initialization: Track Database List Retrieval
Upon the request of a PTC Track Data Team user when a track database is initially selected for audit management, the system shall obtain a list of available track database files from the back office.

Note: Track database initialization is the process of adding track databases and corresponding PTC critical asset data to TDAS for the first time.

SYS, 4.2.1-3 – Track Database List Maintenance
The system shall store and keep current a list of all available track database files selected for audit management.

SYS, 4.2.1-4 – Track Database Initialization: Track Database Selection
The system shall allow a PTC Track Data Team to select a track database for audit management from the list of available track databases.

Note: By selecting a track database for audit management, all PTC critical assets contained within that database are selected for audit management.

SYS, 4.2.1-5 – PTC Critical Asset List Maintenance
The system shall store and keep current a list of PTC critical assets within each track database file selected for audit management.

SYS, 4.2.1-6 – Reference Data Validation Date
The system shall obtain and store the validation date for all reference data uploaded, if the validation date is available.

SYS, 4.2.1-7 – Track Database Initialization: Audit Data Collection Scheduling
When a track database is initially selected for audit management, the system shall use the validation date of the reference data to schedule data collection for the next audit.

SYS, 4.2.1-8 – Track Database Initialization: Reference Data List Generation
When a track database is initially selected for audit management, the system shall generate a list of reference data that is uploaded for PTC critical assets selected for audit management.

SYS, 4.2.1-9 – PTC Critical Asset IDs
The system shall utilize unique identifiers for each PTC critical asset for traceability between track database versions.

SYS, 4.2.1-10 – Track Database IDs

The system shall utilize unique identifiers for each track database making them traceable between versions.

SYS, 4.2.1-11 – Report Generation

The system shall include the capability to retrieve current and past audit status and results upon request from a PTC Track Data Team user.

SYS, 4.2.1-12 – Individual PTC Critical Asset Report Generation
The system shall be capable of generating summary reports for individual PTC critical assets selected for audit management.
Note: Summary reports may include:

- Audit results
- Audit status
- Audit alerts
- Additional information uploaded for PTC critical assets

SYS, 4.2.1-13 – PTC Critical Asset Group Report Generation
The system shall be capable of generating summary reports for groups of PTC critical assets selected for audit management.

SYS, 4.2.1-14 – Subdivision Report Generation
The system shall be capable of generating summary reports for subdivisions.

SYS, 4.2.1-15 – Report Customization
The system shall support user-configuration of summary reports for PTC critical assets selected for audit management.

SYS, 4.2.1-16 – Current Reference Data
The system shall store the most current available reference data for PTC critical assets selected for audit management.

SYS, 4.2.1-17 – Track Database Update: Updated PTC Critical Asset Data Archival
When the system determines that a new version of a track database currently selected for audit management is available, the system shall archive the reference data for PTC critical assets that were updated in the new version.

Note: Track database updating is the modification of track databases and corresponding PTC critical asset data that has previously been uploaded to TDAS.

SYS, 4.2.1-18 – Track Database Update: Removed PTC Critical Asset Data Archival
When the system determines that a new version of a track database currently selected for audit management is available, the system shall archive reference data for PTC critical assets that were removed.

SYS, 4.2.1-19 – Track Database Update: New PTC Critical Asset Audit Parameter Configuration
When the system determines that a new version of a track database currently selected for audit management is available, the system shall support user-configuration of audit parameters for new PTC critical assets.

4.2.2 Alerting Requirements

Alerts are immediate notifications provided to users of the system for audit-related events.

SYS, 4.2.2-1 – Audit Exception Alert
The system shall provide an alert when a PTC critical asset is flagged with an audit exception.

SYS, 4.2.2-2 – Insufficient Data Alert
The system shall provide an alert when a PTC critical asset has been flagged for insufficient data.

Note: Insufficient data refers to data that cannot be used to identify the location of a PTC critical asset within the TBC error budget, or identify discrepancies between critical attributes.

SYS, 4.2.2-3 –PTC Critical Asset Warning Alert
The system shall provide an alert when the location of a PTC critical asset exceeds a defined distance along-track from the location in the track database file.

SYS, 4.2.2-4 –Reference Data Alert
The system shall provide an alert when reference data is required for a PTC critical asset.

SYS, 4.2.2-5 – Audit Data Refresh Date Alert
The system shall provide an alert when audit data has not been collected within the audit data refresh duration for a PTC critical asset.

SYS, 4.2.2-6 – Audit Expiration Alert
The system shall provide an alert when an audit has expired for a PTC critical asset.

SYS, 4.2.2-7 –Audit Exception Alert Retraction
The system shall provide a retraction to an Audit Exception Alert when a PTC critical asset that was flagged with an exception is updated with a "pass" result.

SYS, 4.2.2-8 –Insufficient Data Alert Retraction
The system shall provide a retraction to an Insufficient Data Alert when a PTC critical asset that was flagged for insufficient data is updated with new raw audit data not identified as insufficient.

SYS, 4.2.2-9 – PTC Critical Asset Warning Alert Retraction
The system shall provide a retraction to an PTC Critical Asset Warning Alert when a PTC critical asset that was flagged as exceeding a defined distance along-track from the location in the track database file is determined to be within the defined distance.

SYS, 4.2.2-10 – Reference Data Alert Retraction
The system shall provide a retraction to a Reference Data Alert when a PTC critical asset that was flagged as requiring reference is updated with new reference data.

SYS, 4.2.2-11 – Audit Data Refresh Date Alert Retraction
The system shall provide a retraction to an Audit Data Refresh Date Alert when a PTC critical asset that was flagged for reaching an audit data refresh date is updated with new raw audit data not identified as insufficient.

SYS, 4.2.2-12 – Audit Expiration Alert Retraction
The system shall provide a retraction to an Audit Expiration Alert when a PTC critical asset that was flagged for an expired audit is updated with a complete audit.

4.2.3 Prioritization and Scheduling Requirements

SYS, 4.2.3-1 – Audit Data Comparison Prioritization
The system shall prioritize audit data comparison based on proximity to expiration.

SYS, 4.2.3-2 – Audit Data Collection Prioritization
The system shall prioritize audit data collection based on railroad defined parameters.

SYS, 4.2.3-3 – Audit Data Collection Scheduling
The system shall be capable of scheduling dates for raw audit data collection.

SYS, 4.2.3-4 – PTC Critical Asset Group Data Collection Scheduling
The system shall be capable of scheduling raw audit data collection for groups of PTC critical assets.

SYS, 4.2.3-5 – Subdivision Data Collection Scheduling
The system shall be capable of scheduling raw audit data collection for subdivisions.

SYS, 4.2.3-6 – Audit Process Date Determination
The system shall calculate the following audit process dates for PTC critical assets selected for audit management:

- Audit Date
- Audit Expiration Date
- Audit Data Refresh Notification Date
- Audit Data Collection Date
- Reference Data Validation Date

4.3 Data Storage Requirements

SYS, 4.3-1 – Audit Process Data Storage
The system shall store all data produced by the audit process.

SYS, 4.3-2 – Data Storage Parameter Configuration
The system shall support user configuration of data storage parameters.

SYS, 4.3-3 – Audit Scheduling Parameter Storage
The system shall store audit scheduling parameters for each PTC critical asset selected for audit management.

SYS, 4.3-4 – Audit Process Date Storage
The system shall store audit process dates for each PTC critical asset selected for audit management.

SYS, 4.3-5 – Reference Data Storage
The system shall store reference data for each PTC critical asset selected for audit management.

SYS, 4.3-6 – Audit Parameter Storage
The system shall store audit parameters for each PTC critical asset selected for audit management.

SYS, 4.3-7 – PTC Critical Asset Supplementary Data Storage

The system shall be capable of storing additional text provided by the user in association with the audit result for a PTC critical asset selected for audit management.

4.4 Data Collection Requirements

SYS, 4.4-1 – Automated Raw Audit Data Collection
The system shall support automated raw audit data collection for the assets and attributes listed in Table B 3.

Note: Automated raw audit data collection is the collection of data for assigned PTC critical assets without input from operators.

SYS, 4.4-2 – Manual Raw Audit Data Configuration
The system shall support manual raw audit data collection assets and attributes listed in Table B 3.

Note: Manual raw audit data collection is collection of raw audit data performed by Audit Data Collection Team personnel.

SYS, 4.4-3 – Georeferenced Image Data
When collecting raw audit data, the system shall collect georeferenced image data.

SYS, 4.4-4 – Georeferenced to Block Offset Coordinate Conversion
The system shall be capable of conversion between georeferenced data and block offset coordinate frame.

SYS, 4.4-5 – Georeferenced and Other Coordinate Conversion
The system shall be capable of conversion between georeferenced data and specified coordinate frames.

SYS, 4.4-6 – Date and Time Stamped Data Collection
When collecting raw audit data, the system shall date and time stamp the data.

SYS, 4.4-7 – Reference Data for Data Collection Location
The system shall utilize reference data to identify locations to perform raw audit data collection.

SYS, 4.4-8 – Multiple Data Collection Platforms
The system shall support at least one the following data collection platforms:

- Ground crew
- Locomotive
- Hi-rail vehicle
- Rail car
- Unmanned aerial system

SYS, 4.4-9 – Opportunistic Data Collection
The system shall support opportunistic collection of raw audit data.

Note: Opportunistic data collection is the collection of raw audit data from equipment mounted on vehicles conducting revenue service operations.

SYS, 4.4-10 – Targeted Data Collection
The system shall support targeted raw audit data collection.

Note: Targeted data collection is the collection of raw audit data by track vehicles or ground survey crews not conducting revenue service operations.

SYS, 4.4-11 – Continuous Data Collection
The system shall support uninterrupted raw audit data collection across multiple PTC critical assets.

SYS, 4.4-12 – Intermittent Data Collection
The system shall support discrete raw audit data collection at specified PTC critical asset locations.

SYS, 4.4-13 – Data Collection Subsystem Ease-of-Use
Automated data collection will require little or no input from train crews and can be performed by minimally trained Audit Data Collection Team users.

SYS, 4.4-14 – Data Quality from Opportunistic Data Collection
The system shall support opportunistic data collection without requiring alteration to operation of the revenue service vehicle.

SYS, 4.4-15 – Data Collection Radius
The system shall be capable of collecting data a TBC distance from an equipped track vehicle.

SYS, 4.4-16 – Data Collection Parameter Configuration
The system shall support user-configuration of data collection parameters.

4.5 Data Comparison Requirements

SYS, 4.5-1 – PTC Critical Asset Identification: Raw Audit Data
The system shall be capable of identifying PTC critical assets listed in Table B 3 in raw audit data.

SYS, 4.5-2 – PTC Critical Asset Identification: Reference Data
The system shall be capable of identifying PTC critical assets listed in Table B 3 in reference data.

SYS, 4.5-3 – PTC Critical Asset Location Comparison
The system shall be capable of determining the location of a PTC critical asset in the raw audit data, relative to the position specified in the reference data, within 3.5 feet.

SYS, 4.5-4 – Critical Attribute Identification: Raw Audit Data
The system shall be capable of identifying critical attributes listed in Table B 3 in raw audit data.

Note: Attributes specified for audit management are identified in the Table B 3.

SYS, 4.5-5 – Critical Attribute Identification: Reference Data
The system shall be capable of identifying critical attributes listed in Table B 3 in reference data.

SYS, 4.5-6 – Critical Attribute Discrepancy Identification
The system shall be capable of identifying discrepancies between the critical attributes identified in reference data and the critical attributes identified in raw audit data, for a PTC critical asset.

SYS, 4.5-7 – Insufficient Data Identification
The system shall be capable of identifying insufficient data when raw audit data is compared to reference data.

SYS, 4.5-8 – Exception Identification
The system shall flag a PTC critical asset selected for audit management with an exception if the asset is determined to be outside of a TBC distance from the location defined in the reference data.

SYS, 4.5-9 – Warning Identification
The system shall flag a PTC critical asset selected for audit management with a warning if the asset is determined to be outside of a TBC distance from the location defined in the reference data.

SYS, 4.5-10 – Field Data Configuration
The system shall support data comparison between raw audit data and reference data in the field.

SYS, 4.5-11 – Back office Data Comparison
The system shall support data comparison between raw audit data and reference data in the railroad back office.

SYS, 4.5-12 – Automated Data Comparison
The system shall support automated data comparison between raw audit data and reference data.

Note: Automated data comparison is data comparison performed by a machine requiring little or no Data Comparison Team user input.

SYS, 4.5-13 – Manual Data Comparison
The system shall support manual data comparison between raw audit data and reference data.

Note: Manual data comparison is data comparison performed by Audit Comparison Team users.

SYS, 4.5-14 – Data Comparison Parameter Configuration
The system shall support user-configuration of data comparison parameters.

SYS, 4.5-15 – Individual PTC Critical Asset Data Comparison Prioritization
The system shall be capable of performing data comparison by individual PTC critical assets as configured by the Data Comparison Team user.

SYS, 4.5-16 – PTC Critical Asset Group Data Comparison Prioritization
The system shall be capable of performing data comparison by groups of PTC critical assets as configured by the Data Comparison Team user.

SYS, 4.5-17 – Subdivision Data Comparison Prioritization
The system shall be capable of performing data comparison by subdivision as configured by the Data Comparison Team user.

Appendix C.
Positive Train Control (PTC) Track Data Auditing System (TDAS): Development and Implementation Plan v 1.0

Version 1.0

August 1, 2019

1. Introduction

1.1 Purpose

The purpose of this document is to support the development and documentation of an industry plan for development and implementation of industry-common standards and/or recommended practices relating to Positive Train Control (PTC) track database auditing processes and associated technology solutions by the railroads that use an Interoperable Train Control (ITC) PTC system.

1.2 Industry Needs

To function safely and effectively, PTC systems rely on accurate track data. It is essential that track data used by PTC systems be accurate and up to date for the PTC system to function safely and effectively. Although processes exist to document and update PTC track databases following changes made to the track or other PTC critical assets, the potential exists for changes to occur without the track database being updated. Auditing of the PTC track databases is necessary to ensure that the track data used by the PTC system accurately represents the actual track and PTC critical assets in place. Depending on the approach used, auditing can be a manual, time consuming process that can reduce track availability and consume resources. The processes are manually managed, which can introduce the potential for irregular audit periods. Additionally, much of the current focus of audits is on the identification and handling of exceptions, and less on tracking and record keeping.

While auditing of PTC track data is managed and conducted independently by each railroad, there are potential areas of collaboration in developing open standards and/or best practices around aspects of the audit process and technology used to support the process that can provide value to the industry. Specifically, existing audit processes could be enhanced through the following:

- Standards and/or best practices in audit reporting and audit process, including prioritization and frequency of audits, to remove ambiguity and uncertainty about what information is collected and retained, and how often audits should be performed
- Standards and/or best practices for audit data collection including resolution, range, accuracy, and repeatability, for both manual and automated data collection methods
- Solutions for transfer of large audit data sets, for analysis and retention
- Standards and/or best practices for requirements relating to the production of audit data collection and audit data comparison hardware and software, as well as the interface requirements between subsystems; this allows for multiple vendors to produce solutions for individual audit subsystems that can be interchangeable with minimal impact to the overall auditing process and technology solution
- Development of standard audit data libraries, to support development of automated audit data comparison functions, considering the quantity and variability of PTC critical assets

A system that supports a more automated process for scanning PTC critical assets, and their locations and critical attributes, and auditing PTC track databases, could reduce the resource requirements and improve management of the PTC track data auditing and reporting processes.

1.3 System Overview and Program Focus

The TDAS concept is intended to support the ongoing management of PTC track data to meet the requirements of the ITC system. The system manages auditing of railroad track data for PTC systems that use the ITC PTC data model definition. TDAS manages the track data auditing functions for an organization's entire railway network, including data collection, data storage, data comparison, reporting, and audit prioritization.

Areas the railroads aim to collaborate on, and key objectives of the program include:

- Development of specifications, in the form of standards and/or best practices, for subsystems of an auditing system designed to support flexible implementation and increased automation of auditing functions
- Increased level of standardization of audit management, audit prioritization, and record keeping capabilities across the industry
- Development of standards and/or best practices for specifications relating to automated data collection and automated data comparison capabilities, and evaluation of prototypes of these system capabilities
- Development of standards and/or best practices relating to interfaces between TDAS subsystems

2. TDAS Program Approach

The development and implementation of standards and/or best practices for auditing capabilities and TDAS subsystems, is planned to be executed in a multi-phased approach. The first phase of the program is to define and agree on the desired auditing capabilities and TDAS concepts and functions. Additionally, the first phase includes identifying existing technology or systems that can support the defined capabilities and functions.

The second phase of the program is to develop a detailed set of standards and/or best practices for auditing process and capabilities, TDAS subsystem level requirements and interface specifications. In particular, the second phase is focused on the development of specifications for the TDAS Data Collection and audit management subsystems.

The third phase of the program focuses on expanding current audit management and reporting processes to incorporate the standards and/or best practices for the capabilities defined for these processes. Additionally, the third phase includes the development, evaluation, and implementation of automated audit data collection capabilities. This includes working with vendors to develop these components, based on the standards and/or best practices for the Data Collection subsystem requirements and interfaces, and to test/verify their functionality. It is anticipated that, throughout this phase, data comparison functions will continue to be conducted manually. However, standards and/or best practices for automated data comparison requirements will also be initiated during this phase, while also developing data libraries to support development of these capabilities in the future.

The fourth phase of the program includes the incremental development and testing of capabilities for automated data comparison using TDAS.

2.1 Phase I

Phase I focuses on developing standards and/or best practices for PTC track data auditing capabilities. Additionally, this phase focuses on concepts and high-level requirements for a system that can enhance the PTC track data auditing process through methods such as automated scanning of PTC critical track assets using various sensors and automated detecting and reporting of exceptions by comparing to a reference data set.

The objectives of this phase are to:

- Facilitate and document a railroad consensus on the standards and/or best practices for PTC track data auditing capabilities, as well as the functionality for a system to support PTC track data auditing
- Develop standards and/or best practices for the high-level system specification documentation, based on the identified capabilities and functions
- Survey/evaluate existing technologies and concepts that could meet the documented capabilities and high-level requirements.
- Identify any significant gaps between capabilities and high-level requirements and the identified existing available technology

A Concept of Operations (ConOps) document will be generated to describe the standards and/or best practices for auditing capabilities and TDAS functions, including initial and potential future

applications. From the ConOps, a high-level system requirements specification document will be generated, which will include the basic functional requirements, performance requirements, extensibility requirements, and external interfaces.

This phase will also include market research and documentation of available technologies, sensor types, concepts, and potential vendors that may be able to meet the documented system requirements.

2.2 Phase II

Phase II builds on Phase I to develop more detailed standards and/or best practices at the TDAS subsystem level, including the agreed-upon capabilities, as well as specifications for individual system subsystems. The objectives of the second phase are to:

- Develop standards and/or best practices for capabilities and individual TDAS subsystems:
  - Audit process, documentation and reporting capabilities that each railroad will have
  - TDAS audit Process Management subsystem requirements, for railroads/vendors that choose to implement them to meet the audit process, document, and reporting capabilities
  - TDAS automated audit Data Collection subsystem requirements, which allows for multiple vendors to produce solutions for automated audit data collection that can be interchangeable with minimal impact to the overall auditing process and technology solution
- Develop standards and/or best practices for interfaces between individual TDAS subsystems, which supports interchangeability of individual TDAS subsystems with minimal impact to the overall auditing process and technology solution
- Generate and distribute RFPs for development of proof-of-concept Data Collection subsystem

2.3 Phase III

Phase III focuses on expanding existing audit processes to incorporate the standards and/or best practices relating to process management and reporting capabilities defined in Phase II. Additionally, Phase III includes prototype TDAS automated Data Collection subsystem development, based on the requirements established in Phase II.

Phase III includes testing of the Data Collection subsystem to verify the subsystem capabilities can meet the requirements established in Phase II. Testing will cover a variety of operational conditions, and PTC critical assets. Implementation of automated data collection capabilities by individual railroads may follow, or be conducted in parallel with, the industry development and testing efforts. Generally, it is envisioned that railroads will conduct audit data comparison functions using a manual process during this phase of the program.

In this phase, development of requirements for the automated Data Comparison subsystem of TDAS will be initiated. These requirements will define the desired functionality of the automated Data Comparison subsystem. However, it is anticipated that development of a library of data will be required to complete the requirements and development of this capability.

Objectives of this phase include:

- Development of proof-of-concept automated audit Data Collection subsystem
- Verification performance of the automated Data Collection subsystem against requirements established in Phase II
- Initial production of a data library to support the development of automated data comparison capabilities
- Initial development of subsystem requirements for the TDAS automated Data Comparison subsystem

2.4 Phase IV

Phase IV of the program focuses on the incremental development, testing, and implementation of the TDAS automated Data Comparison subsystem. It is envisioned that the development of the algorithms needed to perform automated data comparison will be an incremental process. A single asset type will be chosen initially and the algorithms to automatically compare the data for this asset type will be developed, based on the requirements established in Phase III and the data library for that asset. Once the initial algorithms for this asset are developed, they can be implemented in parallel with the existing manual data comparison process. In this way, the automated data comparison functions can be evaluated against the manual process, using actual audit data.

It is anticipated that the automated data comparison capability will be implemented using a staged approach, to mature the algorithms while also taking advantage of the capabilities, with limited risk. An evaluation plan will be established with criteria for determining that the automated data comparison function is performing acceptably to advance through each of these stages. For example, when it is established that the automated data collection capability reaches a certain level of accuracy and reliability, it may be used to do an initial comparison, with any exceptions or any uncertainty being reviewed manually, as well as spot checks on those assets for which the algorithm did not report an exception. A further stage may eliminate the spot checks, followed by an additional stage to eliminate manual review of exceptions.

Once the initial functionality has been developed and tested for one asset type, another asset type may be selected to be developed either following, or in parallel with the continued maturity of the algorithms used for the first asset type. Additional asset types may follow, although there may be certain asset types that will always require manual data comparison. The details of the algorithm development, evaluation, maturity and implementation will be further developed in this and following phases.

3. TDAS Architecture and Operational Scenarios

TDAS is conceived to support flexibility in the details of the implementation. The modular design and open standard communication interface is intended to allow each railroad to tailor the system to fit their needs.

3.1 System Architecture

Figure C 1 shows the system architecture, including the subsystems, internal interfaces, and external system interfaces. TDAS capabilities are organized into three subsystems:

- The Process Management subsystem supports consistent data management, prioritization and scheduling, and reporting capabilities.
- The Data Collection subsystem includes capabilities for collecting audit data from the field for each PTC critical asset. Various data collection platforms may be utilized.
- The Data Comparison subsystem includes capabilities for comparing the data collected in the field to a set of reference data. The data can be compared manually or using automated processes.

TDAS will support the use of data collection and data comparison systems developed by multiple vendors through specification of open standard interfaces and requirements. The Process Management subsystem may be capable of communicating with these systems through open standard interfaces defined by the ICDs established in Phase II of the system development, depending on the implementation.

Depending on the implementation, TDAS may also be capable of communicating with existing railroad systems to collect the data needed to perform the audit and deliver system alerts and reports.

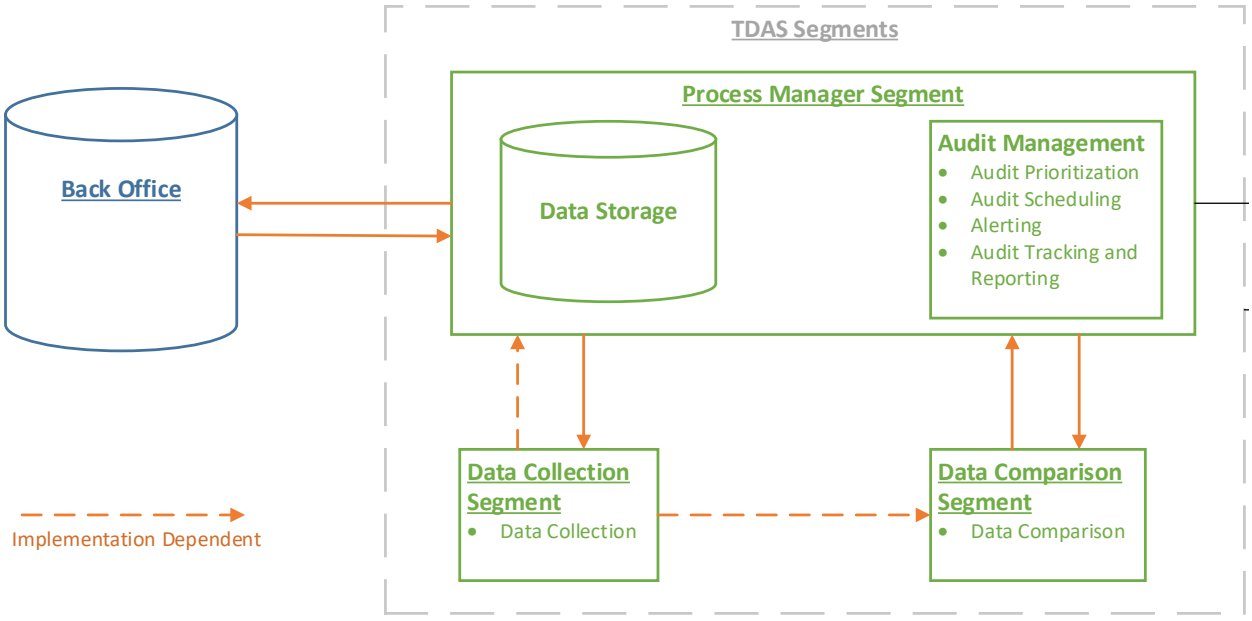

Figure C 1. TDAS System Architecture

It is envisioned that TDAS capabilities can be implemented directly by individual railroads or by service providers that may potentially offer track data auditing capabilities, ranging from those associated with a single TDAS subsystem to all required capabilities. TDAS Process Management, Data Collection, and Data Comparison subsystem capabilities will be defined in a way to allow for easy implementation utilizing either of the above options.

3.2 Operational Scenarios

The following operational scenarios are defined in the TDAS ConOps and are summarized here to provide clarity on the potential implementation options for TDAS capabilities and how they align with the program plan described in Section 2. Figure C 2 illustrates the operational scenarios for TDAS.

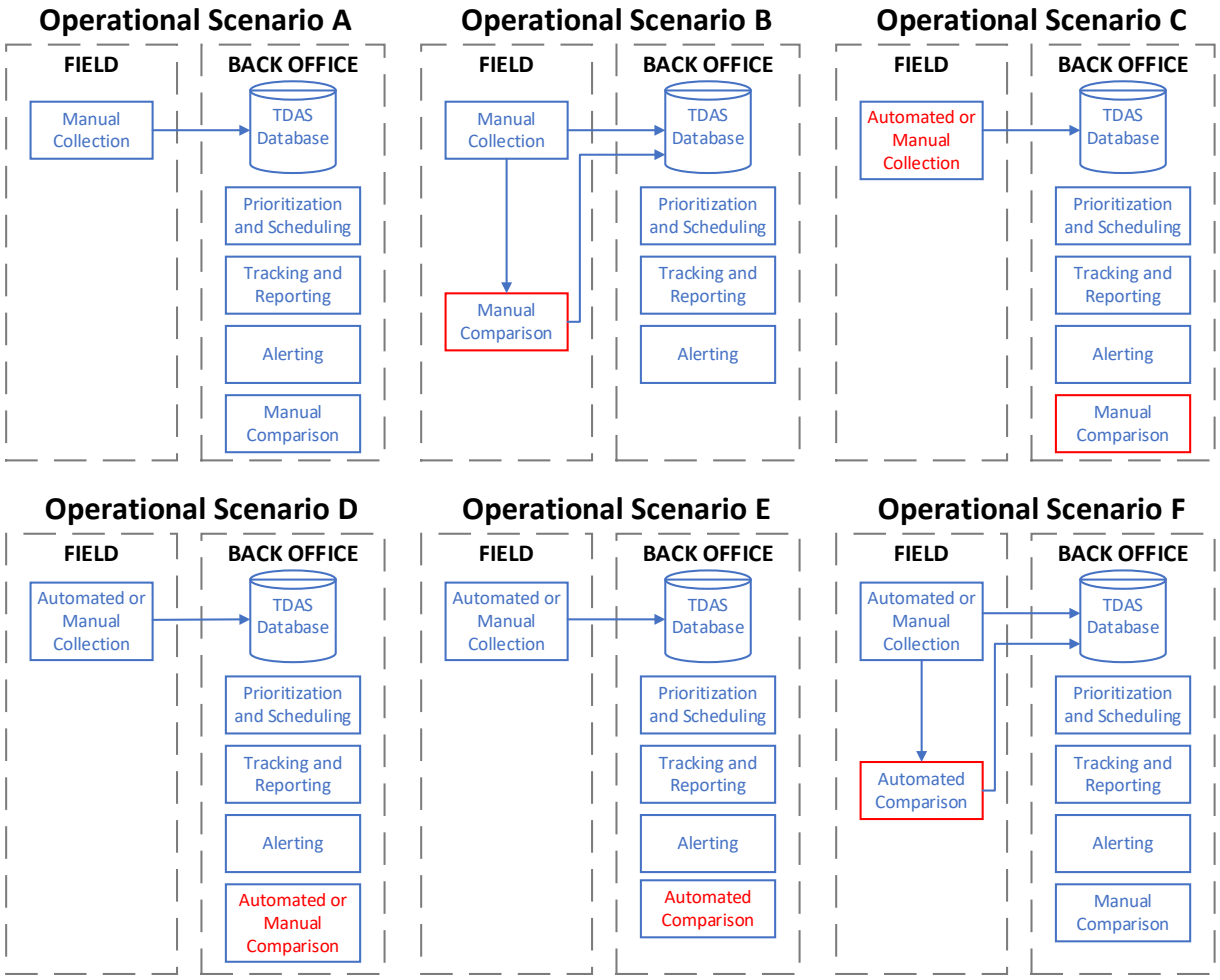

Figure C 2. Operational Scenarios

The capabilities in each of the operational scenarios are:

- Data collection
- Data comparison
- Data storage

- Audit prioritization and scheduling
- Audit tracking and reporting
- Alerting

The method utilized to collect and compare data varies between operational scenarios. There are multiple approaches that can be implemented in the field to collect raw audit data, as well as comparing the data either in the field or back office.

Each operational scenario represents an increased level of automation or a shift in where a capability is implemented from the previous operational scenario, as highlighted in Figure C 2:

- Operational Scenario A and B represent the most basic capabilities defined by TDAS with the primary difference being that manual data comparison is performed in the field for Operational Scenario B and in the back office for A.
- Operational Scenario C introduces the capability of automated data collection.
- Operational Scenario D introduces the capability of automated data comparison.
- Operational Scenarios E and F rely entirely on automated data comparison, with the primary difference being that E is performed in the back office, and F is performed in the field.

The system architecture and operational scenarios are designed to mirror the development and verification of TDAS capabilities by incrementally increasing the level of automation of the auditing functions in each development/implementation phase. One of the fundamental concepts behind the architecture of the system is to provide flexibility in implementation and support incremental improvement through phased development and implementation.

Current implementations of track data auditing most closely resemble Operational Scenario A, with key differences primarily being that audits are typically focused on the identification and handling of exceptions, and not the recording/storage of audit data and results. The current state of audit prioritization and tracking also varies between existing implementations and is, in many cases, not a well-defined process.

Operational Scenario A or B will be supported by standards and/or best practices developed in Phases I and II, and allow the railroad to establish a standardized process for data collection, data comparison, audit status tracking, alerting, and prioritization, using the standard architecture of TDAS. Operational Scenario A or B can then facilitate the incremental implementation of automated data collection in the field as described in Operational Scenario C.

Operational Scenario D coincides with Phase IV and the development of the automated data comparison capabilities. The process of incrementally adding machine vision algorithms may continue until a railroad develops a fully automated process of comparing data as in Operational Scenario E or F. Operational Scenario E and F reduce the labor needed to complete the comparison function of the system and the potential for human error, once the algorithms are shown to be of sufficient accuracy and reliability.

Appendix D.
Positive Train Control (PTC) Track Data Auditing System (TDAS): Process Management Subsystem Requirements Specification v 1.0

Process Management Subsystem Requirements Specification

1. Definitions

Table D 1. Definitions

Term	Definition
Asset Audit Grouping	Grouping of PTC critical assets during audit data comparison, ranging from individual assets to all assets within a track database
Audit	Process of comparing raw audit data against reference data and determining if the data corresponds
Audit Asset Location	Coordinates of a PTC critical asset as determined from the raw audit data
Audit Cycle Duration	Configurable number of days between the audit date and the audit expiration date
Audit Data Collection Date	Date raw audit data was collected
Audit Data Refresh Duration	Configurable number of days between the audit expiration date and the audit data refresh notification date
Audit Data Refresh Notification Date	Date beyond the latest raw audit data collection date at which a notification will be sent indicating new raw audit data is needed
Audit Date	Date that the raw audit data associated with a completed audit was collected
Audit Expiration Date	Date by which a PTC critical asset must be audited
Audit Management	Process of tracking audits, prioritizing and scheduling audits, generating reports, and providing alerts
Audit Parameters	Parameters related to management of the audit process, which at a minimum, include: Audit Scheduling Parameters, alert and report configurations, asset audit grouping configurations
Audit Priority	Variable assigned to a PTC critical asset identifying its priority to be audited, based on its proximity to its Audit Expiration date
Audit Process	Overall process of collecting raw audit data, comparing raw audit data against reference data, and updating/reporting audit status

Term	Definition

Audit Result	Result of the comparison between raw audit data and reference data for an individual PTC critical asset. Set to one of three possible results:
	• Pass:
	  ○ Location of a PTC critical asset as obtained from raw audit data is within an established horizontal accuracy along-track of the location specified in the track database and additional reference data, and
	  ○ Critical attributes of the asset as obtained from raw audit data are determined to match the critical attributes specified in the track database and additional reference data
	• Exception:
	  ○ Location of PTC critical asset as obtained from raw audit data and reference data is not within an established distance along-track of the location specified in the track database and additional reference data, or
	  ○ Critical attributes of the asset are determined not to match the critical attributes specified in the track database and additional reference data
	• Insufficient data: location and/or critical attributes of PTC critical asset as obtained from raw audit data could not be reliably verified

Audit Scheduling Parameters	The subset of Audit Parameters related specifically to the scheduling of audit data collection and data comparison, which may include: auditing PTC critical asset locations, audit groups, audit durations, Audit Priority, etc.
Audit Status	Information pertaining to the raw audit data collection date, audit date, audit data refresh notification date, audit expiration date, and result of last audit
Audit Warning	Alert generated if a PTC critical asset exceeds an established distance along-track from the location stored in the track database
Block Offset	Track referenced coordinate frame with positions relative to the beginning of a block within a track database
Data Collection Parameters	Parameters related to data collection, which may include: collection rates, resolution, timing, etc.
Data Collection Location	Locations over which the Data Collection subsystem begins and ends continuous collection of data

Term	Definition
Data Comparison Parameters	Parameters related to data comparison, such as those related to error tolerances, identification confidences, etc.
Data Storage Parameters	Parameters related to data storage, such as the amount of raw audit data to retain for PTC critical assets, frequency with which to store new raw audit data, quantity of separate raw audit data collections to store for a single asset
Georeferenced	Referenced to a coordinate frame relative to the earth's surface
Image Data	Data including LiDAR point clouds, video, and still image data
LiDAR	A laser-based, remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light.
Machine Vision Sensor	A sensor capable of imaging objects to support machine vision applications.
Opportunistic Data Collection	The collection of raw audit data from equipment mounted on vehicles conducting revenue service operations.
Positive Train Control (PTC)	A form of train control where train movement authorities and speed limits are transmitted electronically and automatically enforced to prevent violations.
PTC Critical Asset	PTC equipment which if destroyed, degraded, relocated, or otherwise rendered unavailable, would affect the safety, reliability or operability of the railroad
PTC Critical Asset Validation Date	Date on which the location and critical attributes of an individual PTC critical asset was validated
PTC Critical Asset Survey Point	A reference point on a PTC critical asset used to represent the location and/or bounds of the asset.
Raw Audit Data	Data collected during audit process; to be compared against reference data
Reference Data	Data related to a PTC critical asset used as a reference for comparison against when conducting an audit (e.g., data contained within the track database, georeferenced data that has been validated against the track database, or relative location information from a referenced object)
System Update	The process of configuring and modifying system parameters

Term	Definition
Targeted Data Collection	Data collection performed as a result of a target order from the Process Management subsystem
Track Database	Onboard track data file, or subdivision file, targeted for use with the onboard system, as defined in the current version of AAR MSRP K-6, S-9503.
Track Database Initialization	The process of adding track databases and corresponding PTC critical asset data to TDAS for the first time.
Track Database Update	The modification of track databases and corresponding PTC critical asset data which has already been uploaded to TDAS.
Reference Data Validation Date	Date on which reference data was validated

2. Introduction

This document specifies the subsystem level requirements for the Process Management subsystem of the Track Data Auditing System (TDAS). The Process Management subsystem performs the primary audit management functions for TDAS. It includes capabilities to:

- Manage prioritization and scheduling of audits
- Manage all data stored and transferred between the back office and TDAS subsystems, including:
  - Track databases
  - Raw audit data
  - Reference data
  - Audit results
  - Audit status
- Allow configuration of audit management capabilities and audit parameters by users
- Provide alerts and reports
- Provide custom reports and data upon user request

To support the raw audit data collection process, the Process Management subsystem provides the required reference data to the Data Collection subsystem and facilitates transfer of audit data from the Data Collection subsystem to the data storage component, as illustrated in Figure D 1. The Process Management subsystem also provides the raw audit data and associated reference data to the Data Comparison subsystem to support the data comparison process and saves the audit results to the data storage component. Upon completion of data comparison, when expiration dates are reached, and for other configurable events, the Process Management subsystem produces reports and alerts related to audit results and status information and stores this data internally in the data storage component.

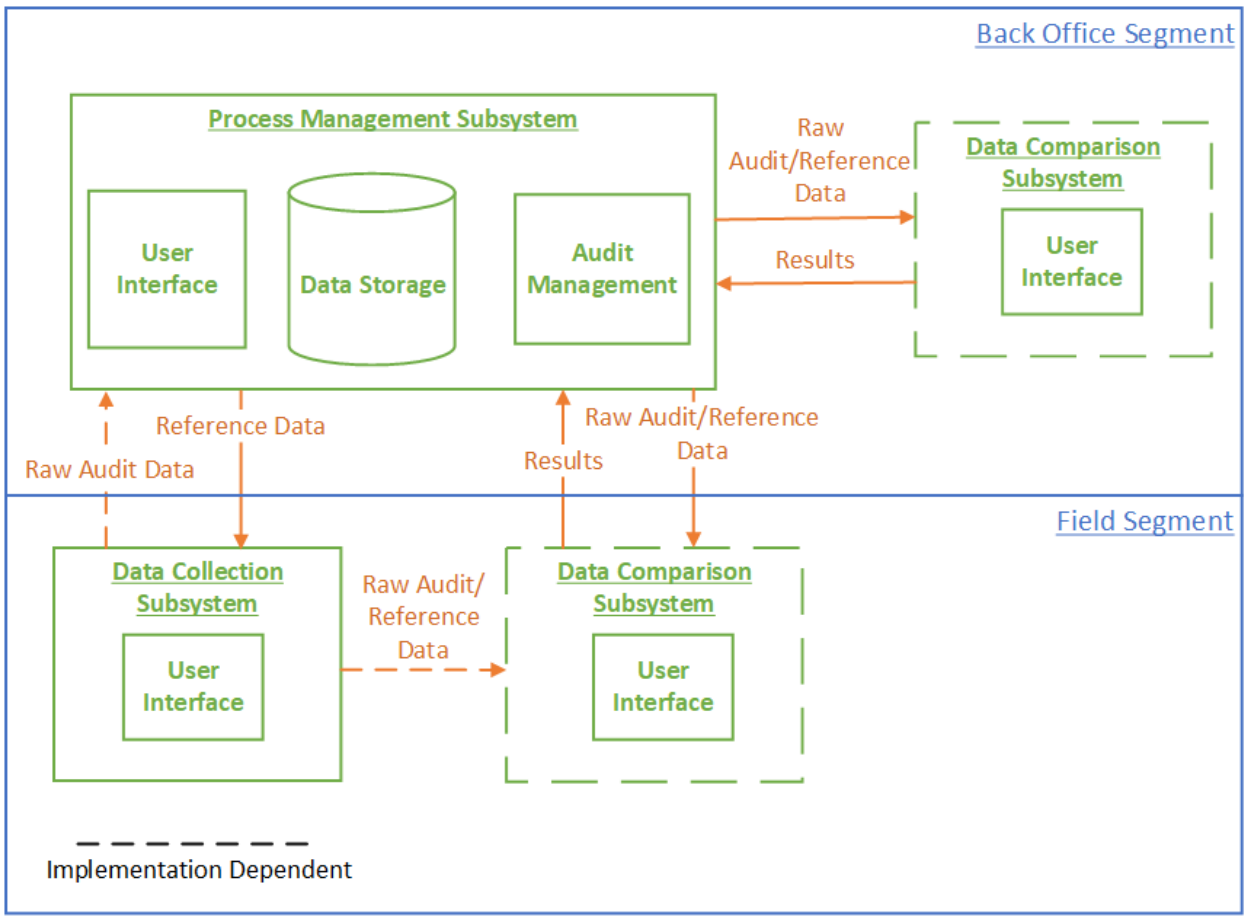

Figure D 1. TDAS Architecture

The Process Management subsystem can be implemented as:

- A standalone entity which interfaces with the other TDAS subsystems and the railroad back office
- A component of the railroad back office which augments existing back office functionality and leverages existing capabilities

2.1 Purpose

This document specifies requirements for an implementation of the Process Management subsystem within the TDAS concept. The Subsystem Requirements section of this document contains the capabilities and functional requirements of the TDAS Process Management subsystem, including:

- Audit management including:
  - Alerting and report generation
  - Prioritization and scheduling
- Data collection support
- Data comparison support

- Subsystem interface requirements

2.2 Applicable Documents

The following documents are applicable to the extent they are referenced in the text of this specification:

- PTC Critical Asset Track Data Auditing System: System Description and Operational Concept v 2.0
- Positive Train Control (PTC) Track Data Auditing System (TDAS) - System Requirements Specification v 2.0
- Positive Train Control (PTC)Track Data Auditing System (TDAS) - Process Management Subsystem-Data Collection Subsystem Interface Control Document v 1.0
- Positive Train Control (PTC)Track Data Auditing System (TDAS) - Process Management Subsystem-Railroad Back Office Interface Control Document v 1.0
- Positive Train Control (PTC)Track Data Auditing System (TDAS) - Process Management Subsystem-Data Comparison Subsystem Interface Control Document v 1.0

2.3 User Classes

Table D 2 defines the user classes referenced in Section 3.

Table D 2. TDAS User Classes

User	Functions
PTC Track Data Team	1. Determine configurable parameters of TDAS 2. Oversee TDAS and the auditing process 3. Oversee track database initialization and track database updates 4. Manage alerts, audit exceptions, and other anomalies
Audit Data Collection Team	1. Manage collection of raw audit data 2. Oversee transfer of raw audit data to the data storage component 3. Schedule targeted collection of raw audit data, as appropriate/required 4. Perform raw audit data collection (if/when raw audit data collection is done manually)
Audit Comparison Team	1. Compare raw audit data against reference data (if processing of data is done manually in the back office)

User	Functions
	2. Oversee processing of raw audit data against reference data (if processing of data is done automatically)
TDAS Maintenance Team	1. Implement updates or changes to TDAS 2. Perform TDAS routine maintenance 3. Troubleshoot TDAS failures

3. Audit Management Requirements

3.1 System Configuration Requirements

SS_PM, 3.1-1 – System Initialization
When the Process Management subsystem is activated for the first time, the subsystem shall begin system initialization.

SS_PM, 3.1-2 – Configuration: Track Database Query Rate
Upon system initialization, the Process Management subsystem shall prompt a Track Data Team user to configure the frequency at which to query the back office for a list of all current track databases available.

SS_PM, 3.1-3 – Configuration: Audit Cycle Duration
Upon system initialization, the Process Management subsystem shall prompt a PTC Track Data Team user to configure the Audit Cycle Duration(s).

SS_PM, 3.1-4 – Configuration Options: Audit Cycle Duration
The Process Management subsystem shall provide the user with the following options when configuring Audit Cycle Duration(s):

- Set a global Audit Cycle Duration for all assets
- Set global Audit Cycle Durations by asset type

SS_PM, 3.1-5 – Configuration Options: Audit Data Refresh Duration
Upon system initialization, the Process Management subsystem shall prompt a PTC Track Data Team user to configure the Audit Data Refresh Duration(s).

SS_PM, 3.1-6 – Configuration: Audit Data Refresh Duration
The Process Management subsystem shall provide the user with the following options when configuring Audit Data Refresh Duration(s):

- Set a global Audit Data Refresh Duration for all assets
- Set global Audit Data Refresh Durations by asset type

SS_PM, 3.1-7 – Configuration: Insufficient Data Count
Upon system initialization, the Process Management subsystem shall prompt a PTC Track Data Team user to configure the number of times an audit result can be “insufficient data” since the last Audit Date, before sending an INSUFFICIENT_DATA alert.

SS_PM, 3.1-8 – Configuration: Custom Report Delivery
Upon system initialization, the Process Management subsystem shall allow a PTC Track Data Team user to configure custom reports to be delivered:

- At scheduled intervals
- On an event driven basis

SS_PM, 3.1-9 – Modification: Track Database Query Rate
The Process Management subsystem shall allow a Track Data Team user to modify the frequency at which to query the back office for a list of all current track databases available, set during system initialization.

SS_PM, 3.1-10 – Modification: Audit Cycle Duration
The Process Management subsystem shall allow a PTC Track Data Team user to modify the Audit Cycle Duration(s) set during system initialization.

SS_PM, 3.1-11 – Modification: Audit Data Refresh Duration
The Process Management subsystem shall allow a PTC Track Data Team user to modify the Audit Data Refresh Duration(s) set during system initialization.

SS_PM, 3.1-12 – Store: Audit Cycle Duration
If a global Audit Cycle Duration changes, the Process Management subsystem shall store the updated Audit Cycle Duration for each PTC critical asset selected for audit management and configured to use a global Audit Cycle Duration.

SS_PM, 3.1-13 –Store: Audit Data Refresh Duration
If a global Audit Data Refresh Duration changes, the Process Management subsystem shall store the updated Audit Data Refresh Duration for each PTC critical asset selected for audit management and configured to use a global Audit Data Refresh Duration.

SS_PM, 3.1-14 –Update: Audit Expiration Date
If a global Audit Cycle Duration changes, the Process Management subsystem shall update the Audit Expiration Date by calculating the Audit Date plus the updated Audit Cycle Duration for each PTC critical asset identified for audit management, configured to use a global Audit Cycle Duration, and affected by the Audit Cycle Duration that was changed.

SS_PM, 3.1-15 – Update: Audit Data Refresh Notification Date
If a global Audit Data Refresh Duration changes, the Process Management subsystem shall update the Audit Data Refresh Notification Date by calculating the Audit Expiration Date minus the updated Audit Data Refresh Duration for each PTC critical asset identified for audit management, and configured to use a global Audit Data Refresh Duration, and affected by the Audit Data Refresh Duration that was changed.

3.2 Track Database Initialization Requirements

Track database initialization is the process through which the railroad user selects a track database for audit management within the TDAS and initializes the audit durations for that track database. Figure D 2 provides an overview of the track database initialization process.

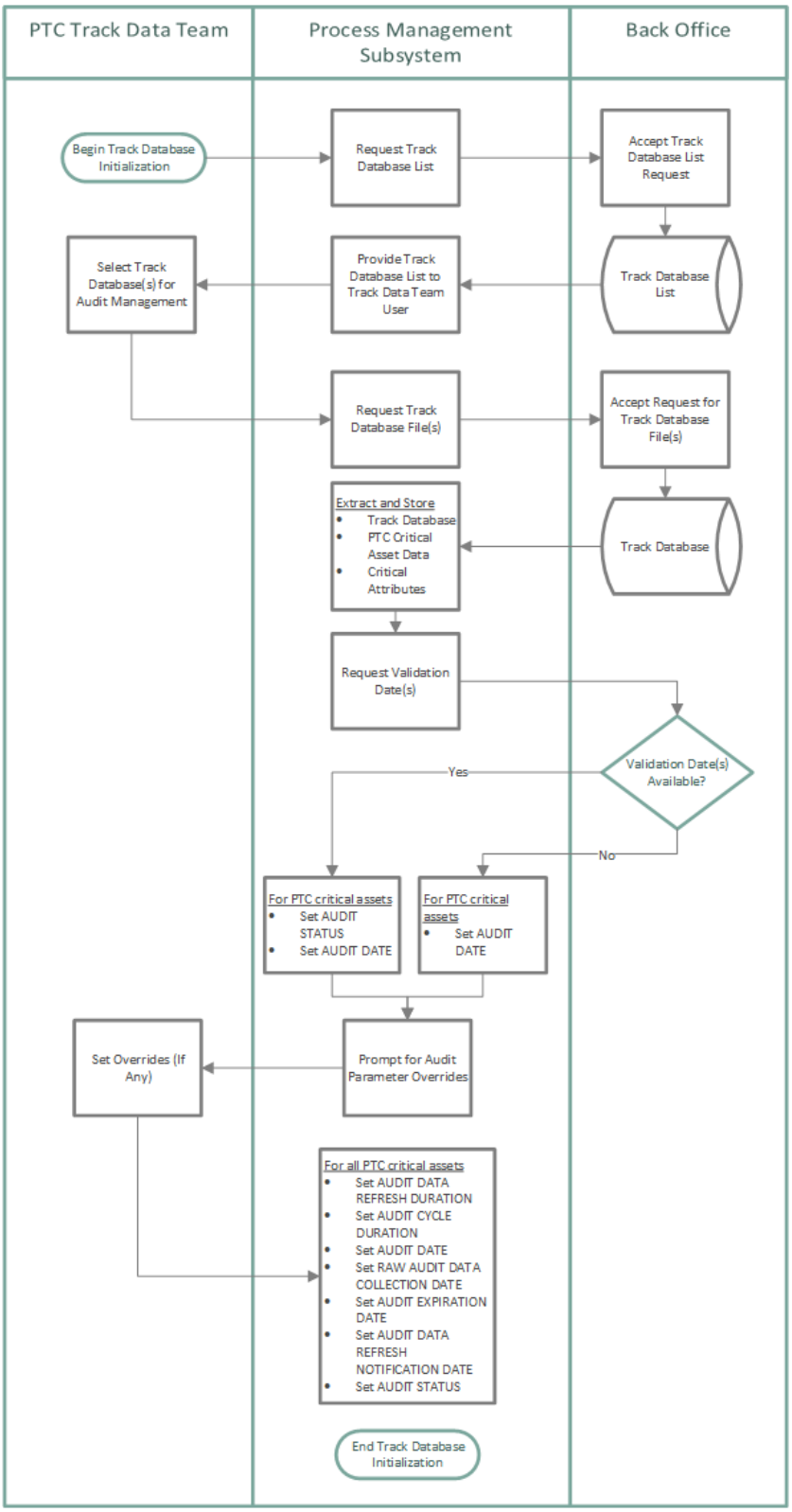

Figure D 2. Track Database Initialization

SS_PM, 3.2-1 – Track Database Initialization: Trigger
The Process Management subsystem shall accept a request from a PTC Track Data Team user to initialize a new track database.

SS_PM, 3.2-2 – Track Database Initialization: Track Database List User Request
When the Process Management subsystem receives a request from a Track Data Team user to initialize a new track database, the Process Management subsystem shall obtain a list of all current track databases available from the back office.

SS_PM, 3.2-3 – Track Database Initialization: Track Database List Accept
When the back office provides the list of track databases, the Process Management subsystem shall accept the list of track databases available from the back office.

SS_PM, 3.2-4 – Track Database Initialization: Track Database List Contents
Upon storing the list of track databases received from the back office, the Process Management subsystem shall display the list of current track databases received from the back office to the PTC Track Data Team user.

SS_PM, 3.2-5 – Track Database Initialization: Track Database Selection Prompt
When the Process Management subsystem displays a list of track databases to a Track Data Team user, the Process Management subsystem shall prompt the PTC Track Data Team user to select the track database(s) to be initialized for audit management.

SS_PM, 3.2-6 – Track Database Initialization: Track Database Request
When a PTC Track Data Team user selects one or more track databases for audit management, the Process Management subsystem shall request the most current track database file for each track database selected for audit management from the back office.

SS_PM, 3.2-7 – Track Database Initialization: Accept/Store Track Database
The Process Management subsystem shall accept and store each track database file received from the back office.

SS_PM, 3.2-8 – Track Database Initialization: Validation Date
Upon track database initialization, the Process Management subsystem shall query the back office for the availability of the Validation Date(s) for each PTC critical asset, in each track database selected for audit management.

SS_PM, 3.2-9 – Track Database Initialization: Track Database Identifiers
Upon receiving each track database selected for audit management from the back office, the Process Management subsystem shall extract and store the subdivision name, Subdivision ID, and the Subdivision File Revision Number, for each for each track database selected for audit management.

SS_PM, 3.2-10 – Track Database Initialization: Extract/Store Asset Type
Upon receiving each track database selected for audit management from the back office, the Process Management subsystem shall extract and store the asset type for all PTC critical assets contained within each track database selected for audit management.

Note: PTC critical asset types are listed in Table D 3.

SS_PM, 3.2-11 – Track Database Initialization: Extract: Extract/Store Critical Attributes
Upon receiving each track database selected for audit management from the back office, the Process Management subsystem shall extract and store critical attribute data for all PTC critical assets contained within each track database selected for audit management.

Note: Critical attributes are listed in Table D 3.

SS_PM, 3.2-12 – Track Database Initialization: Extract/Store Location
Upon receiving each track database selected for audit management from the back office, the Process Management subsystem shall extract and store the asset location for all PTC critical assets contained within each track database selected for audit management.

SS_PM, 3.2-13 – Track Database Initialization: Extract/Store PTC Asset Data Source ID
Upon receiving each track database selected for audit management from the back office, the Process Management subsystem shall extract and store the PTC Data Source ID for each PTC critical asset contained within each track database selected for audit management.

Table D 3. PTC Critical Assets and Attributes

PTC Critical Assets	Attributes
Track centerline	
Integer mileposts, milepost signs	Sign text (optional)
Signals	Direction of signal Type of signal Signal graphic
Crossings, road crossings at grade	
Switches	Turnout leg Switch orientation
Permanent speed restrictions, speed signs	Sign text (optional)
Track detection circuit limits in non-signaled territory	
Inside switches equipped with switch circuit controllers	
Method of operation signs	Sign text (optional)
Derails	

SS_PM, 3.2-14 – Track Database Initialization: Audit Cycle Duration Override
Upon completion of extracting and storing data from a track database selected for audit management, The Process Management subsystem shall provide the PTC Track Data Team user the option to set overrides for the Audit Cycle Duration(s) for the PTC critical assets contained in the track database.

SS_PM, 3.2-15 – Audit Cycle Duration Override Options
When a PTC Track Data Team user is setting overrides for the Audit Cycle Duration(s) for the PTC critical assets contained in a track database, the Process Management subsystem shall provide the following options:

1. Keep global Audit Cycle Duration defaults
2. Override the Audit Cycle Duration defaults by setting a duration for the all PTC critical asset types in the track database
3. Override the global Audit Cycle Duration defaults by setting the duration for each PTC critical asset type
4. Override the global Audit Cycle Duration defaults by setting the duration for individual PTC critical asset

SS_PM, 3.2-16 – Track Database Initialization: Audit Data Refresh Duration Override
When the PTC Track Data Team user has completed setting the Audit Cycle Duration for the PTC critical assets contained in the track database, the Process Management subsystem shall provide the PTC Track Data Team user the option to set overrides for the Audit Data Refresh Duration(s) for the PTC critical assets contained in the track database.

SS_PM, 3.2-17 – Audit Data Refresh Duration Override Options
When a PTC Track Data Team user is setting overrides for the Audit Data Refresh Duration(s) for the PTC critical assets contained in a track database, the Process Management subsystem shall provide the following options:

1. Keep global Audit Data Refresh Duration defaults
2. Override the global Audit Data Refresh Duration defaults by setting a duration for the all PTC critical asset types in the track database
3. Override the global Audit Data Refresh Duration defaults by setting the duration for each PTC critical asset type
4. Override the global Audit Data Refresh Duration defaults by setting the duration for individual PTC critical asset

SS_PM, 3.2-18 – Track Database Initialization: Required Reference Data
When the PTC Track Data Team user has completed setting the Audit Data Refresh Duration for the PTC critical assets contained in the track database, The Process Management subsystem shall provide the PTC Track Data Team user the option to indicate if additional reference data is required for PTC critical asset(s) selected for audit management.

SS_PM, 3.2-19 – Track Database Initialization: Audit Date Set (Validation Date)
Upon receiving the Validation Date of each PTC critical asset contained in the track database, the Process Management subsystem shall set the Audit Date to the Validation Date of the most recently validated reference data for each PTC critical asset in the track database selected for audit management.

SS_PM, 3.2-20 – Track Database Initialization: Audit Date Set (No Validation Date)
If the Validation Date of the additional reference data is not available for PTC critical asset(s) contained in the track database, the Process Management subsystem shall set the Audit Date to

the current date minus the Audit Cycle Duration for each PTC critical asset in the track database selected for audit management.

SS_PM, 3.2-21 – Track Database Initialization: Audit Data Collection Date Set
When the PTC Track Data Team user has completed setting the Audit Data Refresh Duration for the PTC critical assets contained in the track database, the Process Management subsystem shall set the Raw Audit Data Collection Date to the Audit Date for each PTC critical asset identified in the track database selected for audit management.

SS_PM, 3.2-22 – Track Database Initialization: PTC Asset Audit Expiration Date
When the PTC Track Data Team user has completed setting the Audit Data Refresh Duration for the PTC critical assets contained in the track database, the Process Management subsystem shall set the Audit Expiration Date as the Audit Date plus the Audit Cycle Duration, for each PTC critical asset in the track database selected for audit management.

SS_PM, 3.2-23 – Track Database Initialization: Audit Data Refresh Notification Date Calculation
When the PTC Track Data Team user has completed setting the Audit Data Refresh Duration for the PTC critical assets contained in the track database, the Process Management subsystem shall set the Audit Data Refresh Notification Date as the Audit Expiration Date minus the Audit Data Refresh Duration for each PTC critical asset identified in the track database selected for audit management.

SS_PM, 3.2-24 – Track Database Initialization: PTC Asset Audit Status
When the PTC Track Data Team user has completed setting the Audit Data Refresh Duration for the PTC critical assets contained in the track database, if the Validation Date(s) of PTC critical assets in the track database are available, the Process Management subsystem shall set a "pass" audit result for each PTC critical asset identified in the track database selected for audit management.

SS_PM, 3.2-25 – Track Database Initialization: PTC Asset Audit Data Refresh Duration
When the PTC Track Data Team user has completed setting the Audit Data Refresh Duration for the PTC critical assets contained in the track database, the Process Management subsystem shall store the Audit Data Refresh Duration for each PTC critical asset selected for audit management.

After completion of track database selection and setting of audit parameters, the Process Management subsystem will initiate the process of uploading any additional reference data that may be available, as illustrated in Figure D 3.

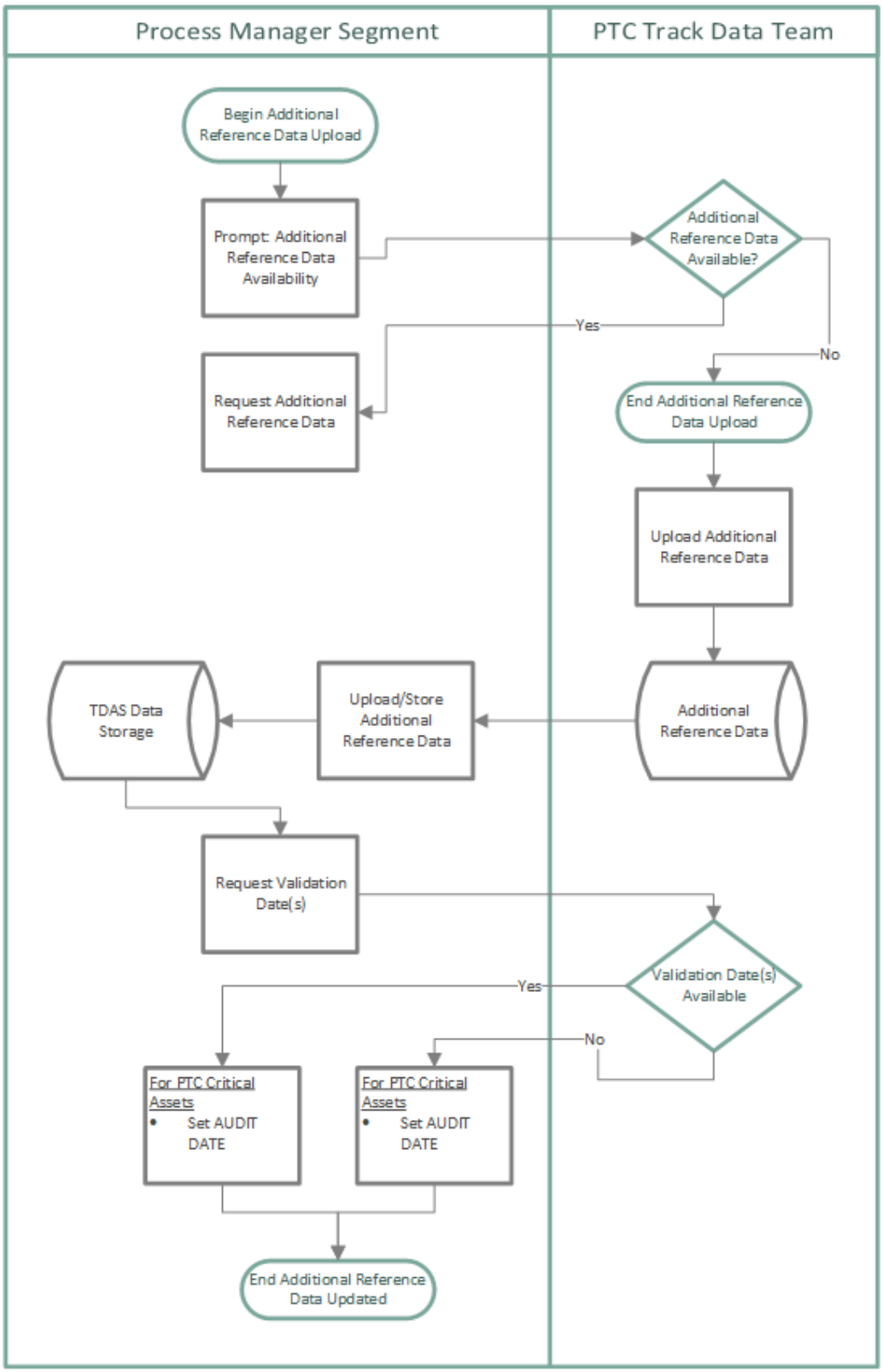

Figure D 3. Additional Reference Data Upload

SS_PM, 3.2-26 – Track Database Initialization: Additional Reference Data
Upon completing setting audit parameters for each PTC critical asset in the track database selected for audit management, the Process Management subsystem shall prompt the PTC Track Data Team user for the availability of additional reference data, for any PTC critical asset identified in the track database selected for audit management.

SS_PM, 3.2-27 – Track Database Initialization: Additional Reference Data Upload
If a Track Data Team user indicates additional reference data is available, the Process Management subsystem shall prompt the PTC Track Data Team user to upload the reference data for each PTC critical asset in each track database selected for audit management, for which reference data is available.

SS_PM, 3.2-28 – Track Database Initialization: Additional Reference Data Storage
Upon a PTC Track Data Team user uploading additional reference data for a PTC critical asset, the Process Management subsystem shall store the additional reference data uploaded by a PTC Track Data Team user for each PTC critical asset selected for audit management.

SS_PM, 3.2-29 – Additional Reference Data ID
The Process Management subsystem shall reference, additional reference data associated with each PTC critical asset, at a minimum, by the Subdivision ID, Subdivision File Revision Number, and the Data Source ID to which it applies.

SS_PM, 3.2-30 – Additional Reference Data Validation Date(s) Request
When a Track Data Team user uploads additional reference data, the Process Management subsystem shall prompt the Track Data Team user for the availability of the Validation Date(s) for the reference data.

SS_PM, 3.2-31 – Additional Reference Date Validation Date(s)
If a Track Data Team user indicates the Validation Date(s) of additional reference data is available, the Process Management subsystem shall prompt the PTC Track Data Team user to provide the Validation Date(s) for the additional reference data.

SS_PM, 3.2-32 – Additional Reference Data: Audit Date Set (Validation Date)
Upon receiving the Validation Date of additional reference data for a PTC critical asset, the Process Management subsystem shall set the Audit Date to the Validation Date of the most recently validated reference data for the PTC critical asset.

SS_PM, 3.2-33 – Additional Reference Data: Audit Date Set (No Validation Date)
If the Validation Date of the additional reference data is not available for a PTC critical asset, the Process Management subsystem shall set the Audit Date to the current date minus the Audit Cycle Duration for the PTC critical asset.

SS_PM, 3.2-34 – Additional Reference Data: PTC Asset Audit Status
When a PTC Track Data Team user uploads additional reference data for a PTC critical asset, and the Validation Date of the additional reference data is available, the Process Management subsystem shall set a "pass" audit result for the PTC critical asset.

SS_PM, 3.2-35 – Additional Reference Data: Raw Audit Data Collection Date
When a PTC Track Data Team user uploads additional reference data for a PTC critical asset, and the Validation Date of the additional reference data is available, the Process Management subsystem shall update the Audit Data Collection Date to the date the reference data was validated for the PTC critical asset.

3.3 Track Database Update Requirements

The track database update is the modification of a track database and corresponding PTC critical asset data which has previously been uploaded to TDAS. The track database update process begins by checking the current version of each track database against the version referenced by the Process Management subsystem, and is initiated either by a request for reference data from the Data Collection subsystem, or at a railroad configurable frequency. Figure D 4 illustrates the track database update process.

Upon update of a track database, the Process Management subsystem will also prompt a Track Data Team user for the availability of additional reference data for new PTC critical assets or updated additional reference data for existing PTC critical assets, as illustrated in Figure D 5.

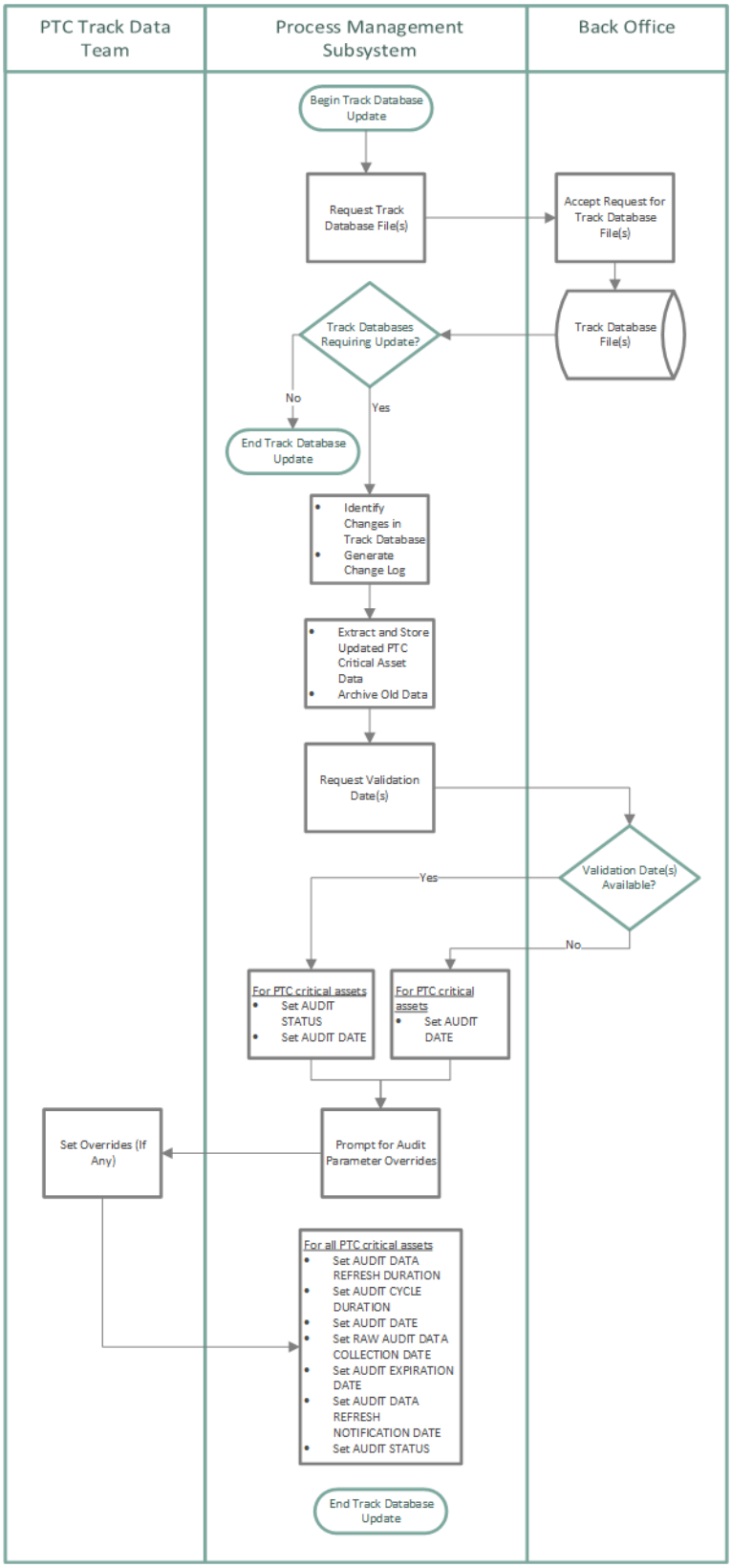

Figure D 4. Track Database Update Process

SS_PM, 3.3-1 – Track Database Update: Database List Query Frequency
The Process Management subsystem shall request the most current track database file for each track database selected for audit management from the back office at the configured frequency.

SS_PM, 3.3-2 – Track Database Request: Data Collection Subsystem Request
When the Data Collection subsystem requests reference data, the Process Management subsystem shall request the most current track database file for each track database selected for audit management from the back office.

SS_PM, 3.3-3 – Track Database Update: Track Database File Store
If the version of a track database received from the back office is different from the version stored as the current version by the Process Management subsystem, the Process Management subsystem shall store the updated track database file(s) from the back office.

SS_PM, 3.3-4 – Track Update: PTC Asset Add/Remove Identification
When the Process Management subsystem stores an updated track database file from the back office, the Process Management subsystem shall compare the PTC critical asset Data Source IDs in the current version of the track database against the PTC critical asset Data Source IDs in the version of the track database previously stored as the current version by the Process Management subsystem to identify any PTC critical assets that have been added or removed.

SS_PM, 3.3-5 – Track Database Update: PTC Asset Modification Identification
When the Process Management subsystem stores an updated track database file from the back office, the Process Management subsystem shall compare the PTC critical asset locations and PTC critical attributes in the current version of the track database against the PTC critical asset locations and PTC critical attributes in the version of the track database previously stored as the current version by the Process Management subsystem to identify any PTC critical asset locations or critical attributes that have been modified.

SS_PM, 3.3-6 – Track Database Update: PTC Asset Change Log
If PTC critical assets are identified as new or identified as having modified locations or critical attributes in a track database file received from the back office, the Process Management subsystem shall identify the PTC critical assets that have been added, removed, or had locations or critical attributes modified in a change log within the Process Management subsystem.

SS_PM, 3.3-7 – Track Database: Archive Audit Information
When the Process Management subsystem stores an updated track database file from the back office, the Process Management subsystem shall archive information pertaining to previous audits associated with each PTC critical asset that was removed or had location or critical attributes modified:

- Subdivision ID
- Subdivision File Revision Number
- Data Source ID
- Audit Date
- Audit Status
- Raw audit data

- Reference data associated with each PTC critical asset that was removed or modified

SS_PM, 3.3-8 – Track Database Update: Track Database Identifiers
When Process Management subsystem stores an updated track database file from the back office, the Process Management subsystem shall extract and update the Subdivision ID and Subdivision File Revision Number for each track database.

SS_PM, 3.3-9 – Track Database Update: PTC Asset Identifiers
When the Process Management subsystem stores an updated track database file from the back office, the Process Management subsystem shall update the Subdivision File Revision Number and PTC Data Source ID for all PTC critical assets identified in each updated track database to the Subdivision File Revision Number of the version of the track database provided by the back office.

SS_PM, 3.3-10 – Track Database Update: PTC Asset Validation Date Verification
When the Process Management subsystem stores an updated track database file from the back office, the Process Management subsystem shall request the availability of the Validation Date for each PTC critical asset in the updated track database file from the back office.

SS_PM, 3.3-11 – Track Database Update: Validation Date
If the back office indicates the Validation Date of a PTC critical asset selected for audit management is available, the Process Management subsystem shall request the Validation Date for the PTC critical asset from the back office.

SS_PM, 3.3-12 – Track Database Update: PTC Asset Audit Date – Additional Reference Data
If the back office provides a Validation Date(s) for a PTC critical asset(s) contained in an updated track database, the Process Management subsystem shall set the Audit Date to the Validation Date for the PTC critical asset(s) that was added or modified.

SS_PM, 3.3-13 –Track Database Update: PTC Asset Audit Date Calculation
If a Track Data Team user indicates the Validation Date is not available for a PTC critical asset(s) in an updated track database, the Process Management subsystem shall set the Audit Date to the current date minus the Audit Cycle Duration for the PTC critical asset(s) that was added or modified.

SS_PM, 3.3-14 – Track Database Update: PTC Asset Audit Cycle Duration
When the Process Management subsystem stores an updated track database file from the back office, the Process Management subsystem shall set the Audit Cycle Duration to the global Audit Cycle Duration for each PTC critical asset that was added or modified.

SS_PM, 3.3-15 – Track Database Update: PTC Asset Audit Expiration Date Calculation
If PTC critical assets are identified as new or modified in a track database file received from the back office and stored as the current version by the Process Management subsystem, the Process Management subsystem shall calculate and store the Audit Expiration Date as the Audit Date plus the Audit Cycle Duration for each PTC critical asset that was added or modified.

SS_PM, 3.3-16 – Track Database Update: PTC Asset Audit Expiration Date
If the version of a track database provided by the back office is different from the version referenced by the Process Management subsystem, the Process Management subsystem shall set the Audit Expiration Date for each PTC critical asset that was added or modified.

SS_PM, 3.3-17 – Track Database Update: PTC Asset Audit Data Refresh Duration
When the Process Management subsystem stores an updated track database file from the back office, the Process Management subsystem shall set the Audit Data Refresh Duration to the global Audit Data Refresh Duration for each PTC critical asset that has been added or modified.

SS_PM, 3.3-18 – Track Database Update: PTC Asset Audit Data Refresh Notification Date Calculation
If PTC critical assets are identified as new or modified in a track database file received from the back office and stored as the current version by the Process Management subsystem, the Process Management subsystem shall calculate and store the Audit Data Refresh Notification Date as the Audit Expiration Date minus the Audit Data Refresh Duration for each PTC critical asset.

SS_PM, 3.3-19 – Track Database Update: PTC Asset Audit Data Refresh Notification Date
If the version of a track database provided by the back office is different from the version referenced by the Process Management subsystem, the Process Management subsystem shall set the Audit Data Refresh Notification Date for each PTC critical asset that was added or modified.

SS_PM, 3.3-20 – Track Database Update: PTC Asset Audit Date Reset
When the Process Management subsystem stores an updated track database file from the back office, and the Validation Date for each PTC critical asset is available and is more recent than the current Audit Date, the Process Management subsystem shall reset the Audit Date for each PTC critical asset that was not added, modified, or removed to the date the updated track database was validated.

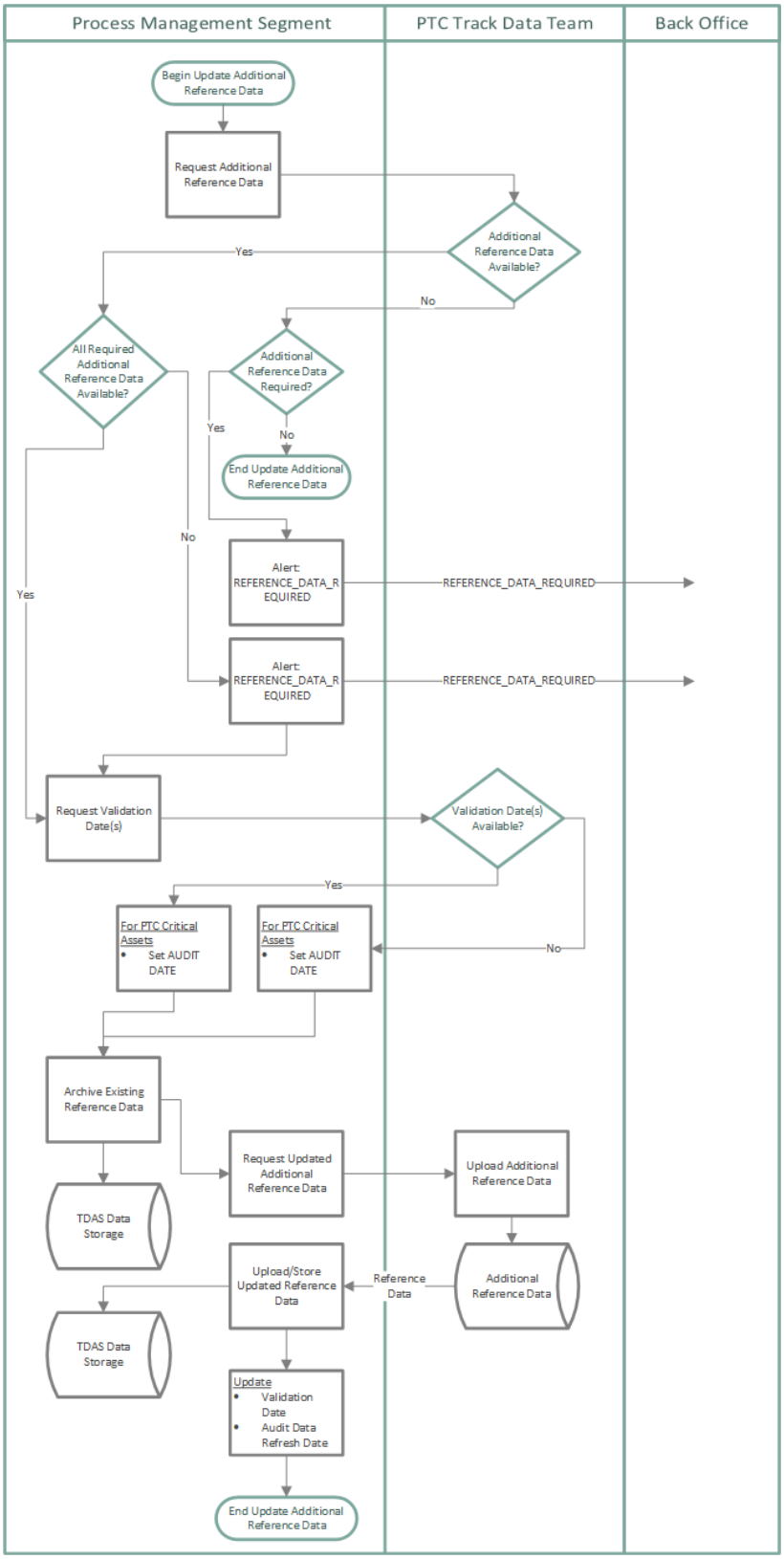

Figure D 5. Additional Reference Data Update

SS_PM, 3.3-21 – Update: Additional Reference Data
If the version of a track database provided by the back office is different from the version previously referenced by the Process Management subsystem the Process Management subsystem shall notify a PTC Track Data Team user that feedback on availability of additional reference data, for any PTC critical asset(s) that was added or modified.

SS_PM, 3.3-22 – Track Database Update: PTC Asset Additional Reference Data Validation
Upon track database update, if additional reference data is available for the PTC critical asset(s) that was added or modified, the Process Management subsystem shall prompt the PTC Track Data Team user to confirm that the reference data has been validated.

SS_PM, 3.3-23 – Track Database Update: PTC Asset Additional Reference Data Upload
Upon track database update, if additional reference data is available for the PTC critical asset(s) that was added or modified, the Process Management subsystem shall prompt the PTC Track Data Team user to upload the reference data for each PTC critical asset that was identified as being added or modified in the updated track database.

SS_PM, 3.3-24 – Track Database Update: PTC Asset Additional Reference Data Storage
When a PTC Track Data Team user uploads additional reference data for PTC critical assets that were added or modified, the Process Management subsystem shall store the reference data uploaded for each PTC critical asset that was added or modified.

SS_PM, 3.3-25 – Additional Reference Data: PTC Asset Audit Date
If reference data for PTC critical asset(s) is updated, and the Validation Date for the reference data is available for the PTC critical assets that have been added or modified, the Process Management subsystem shall set the Audit Date to the date the reference data for the added or modified PTC critical asset(s) was validated.

SS_PM, 3.3-26 – Additional Reference Data: PTC Asset Audit Date (No Validation Date)
If reference data for PTC critical asset(s) is updated, and the Validation Date of the reference data that has been added or modified is not available, the Process Management subsystem shall set the Audit Date for the added or modified PTC critical asset(s) to the current date minus the Audit Cycle Duration.

3.4 Track Database Audit Parameter Modification Requirements

Track database modification describes the modification of audit parameters for a track database selected for audit management, outside of track database initialization or track database update.

SS_PM, 3.4-1 – Track Database Variable Modification

The Process Management subsystem shall allow a PTC Track Data Team user to select a track database(s) for modification of audit parameters.

SS_PM, 3.4-2 – Modification: Audit Cycle Duration

The Process Management subsystem shall allow a PTC Track Data Team user to modify the Audit Cycle Duration(s) for a track database selected for audit management in any of the following ways:

1. Modify the Audit Cycle Duration by setting a duration for all PTC critical asset types in the track database,

2. Modify the Audit Cycle Duration by setting the duration for each PTC critical asset type,
3. Modify the Audit Cycle Duration by setting the duration for individual PTC critical assets.

SS_PM, 3.4-3 – Modification: Audit Data Refresh Duration

The Process Management subsystem shall allow a PTC Track Data Team user to modify the Audit Data Refresh Duration(s) for a track database selected for audit management in any of the following ways:

1. Modify the Audit Data Refresh Duration by setting a duration for all PTC critical asset types in the track database
2. Modify the Audit Data Refresh Duration by setting the duration for each PTC critical asset type
3. Modify the Audit Data Refresh Duration by setting the duration for individual PTC critical assets

SS_PM, 3.4-4 – Modification: Required Reference Data

The Process Management subsystem shall allow a PTC Track Data Team user the option to indicate if additional reference data is required for PTC critical asset(s) selected for audit management.

SS_PM, 3.4-5 – Modification: Custom Report Delivery

The Process Management subsystem shall allow a PTC Track Data Team user to configure custom reports to be delivered:

- At scheduled intervals
- On an event driven basis

SS_PM, 3.4-6 – Audit Cycle Duration Storage

If the Audit Cycle Duration changes for a PTC critical asset, the Process Management subsystem shall store the updated Audit Cycle Duration for that PTC critical asset.

SS_PM, 3.4-7 – Audit Expiration Date Storage

If the Audit Expiration Date changes for a PTC critical asset, The Process Management subsystem shall store the updated Audit Expiration Date for that PTC critical asset.

SS_PM, 3.4-8 – Audit Data Refresh Notification Storage

If the Audit Data Refresh Notification Date changes for a PTC critical asset, The Process Management subsystem shall store the updated Audit Data Refresh Notification Date for that PTC critical asset.

SS_PM, 3.4-9 – Reference Data: Upload

The Process Management subsystem shall allow a PTC Track Data Team user to upload reference data for any PTC critical asset for which reference data has become available at any time after the track database has been initialized for audit management.

3.5 Tracking and Reporting Requirements

SS_PM, 3.5-1 – Track Database Unique Identifier Variables
The Process Management subsystem shall use the Subdivision ID and the Subdivision File Revision Number as the unique identifier for each track database selected for audit management.

SS_PM, 3.5-2 – PTC Asset Unique Identifier
The Process Management subsystem shall use the PTC Data Source ID, Subdivision ID, and the Subdivision File Revision Number as the unique identifiers for each PTC critical asset selected for audit management.

SS_PM, 3.5-3 – Reference Data: Flag for Collection
If reference data is required and not available for a PTC critical asset identified in a track database selected for audit management, the Process Management subsystem shall flag the PTC critical asset for collection of the reference data.

SS_PM, 3.5-4 –Report Generation: Data Retrieval
The Process Management subsystem shall be capable of retrieving audit process data from the data storage component for each PTC critical asset selected for audit management.

SS_PM, 3.5-5 – Report Generation: Audit Information External System
The Process Management subsystem shall be capable of providing custom, read-only reports for any PTC critical asset(s) selected for audit management including:

- Audit History
- Audit Status
- Reference Data
- Raw Audit Data
- Audit Data Refresh Duration
- Audit Cycle Duration

SS_PM, 3.5-6 – Custom Reports: User Request
The Process Management subsystem shall generate custom, read-only reports at request of a PTC Track Data Team user.

SS_PM, 3.5-7 – Custom Reports: Scheduled Interval
If configured accordingly, the Process Management subsystem shall generate custom, read-only reports at scheduled intervals.

SS_PM, 3.5-8 – Custom Reports: Event Driven
If configured accordingly, the Process Management subsystem shall generate custom, read-only reports on an event-driven basis.

3.6 Alerting Requirements

SS_PM, 3.6-1 – Alert: Request Reference Data
When the Process Management subsystem stores an updated track database file from the back office, the Process Management subsystem shall issue an REQUEST_REFERENCE_DATA alert message to the back office.

SS_PM, 3.6-2 – Alert: Reference Data Required
If reference data is required, but not available for a PTC critical asset, the Process Management subsystem shall issue an REFERENCE_DATA_REQUIRED alert message to the back office.

SS_PM, 3.6-3 – Alert: Audit Exception
The Process Management subsystem shall send an AUDIT_EXCEPTION alert message to the back office when an audit of a PTC critical asset results in an "exception".

SS_PM, 3.6-4 –Alert: Insufficient Data
The Process Management subsystem shall send an INSUFFICIENT_DATA alert message to the back office when the audit result has been "insufficient data" a railroad configurable number of times since the last Audit Date.

SS_PM, 3.6-5 – Alert: PTC Asset Warning
The Process Management subsystem shall send an ASSET_LOCATION_CLOSE_TO_EXCEEDING_LIMITS alert message to the back office if the audited PTC critical asset is identified to be greater than 1.5 meters outside of its identified location along the track centerline in the PTC track database.

SS_PM, 3.6-6 – Alert: Audit Data Refresh Notification
The Process Management subsystem shall send an AUDIT_DATA_REFRESH_NOTIFICATION alert message to the back office when the Audit Data Refresh Notification Date for a PTC critical asset has been reached.

SS_PM, 3.6-7 – Alert: Audit Expired
The Process Management subsystem shall send an AUDIT_EXPIRED alert message to the back office when the Audit Expiration Date for a PTC critical asset has been reached.

SS_PM, 3.6-8 – Alert: Track Database Update
The Process Management subsystem shall send a TRACK_DATABASE_UPDATED alert message to the back office if the version of a track database provided by the back office includes PTC critical assets that have been added or modified.

SS_PM, 3.6-9 –Alert Retraction: Reference Data Required
The Process Management subsystem shall send a REFERENCE_DATA_REQUIRED retraction message to the back office if a REFERENCE_DATA_REQUIRED message has been sent for a PTC critical asset and reference data has been uploaded for the PTC critical asset.

SS_PM, 3.6-10 – Alert Retraction: Audit Exception – Audit Pass
The Process Management subsystem shall send a AUDIT_EXCEPTION retraction message to the back office if an AUDIT_EXCEPTION alert message has been sent for a PTC critical asset and an updated audit results in a "pass" for that PTC critical asset.

SS_PM, 3.6-11 – Alert Retraction: Audit Exception – Override
The Process Management subsystem shall send a AUDIT_EXCEPTION retraction message to the back office if an AUDIT_EXCEPTION alert message has been sent for a PTC critical asset and a PTC Track Data Team user overrides the audit result.

SS_PM, 3.6-12 – Alert Retraction: PTC Asset Warning – Distance
The Process Management subsystem shall send a ASSET_LOCATION_CLOSE_TO_EXCEEDING_LIMITS retraction message to the back office if an ASSET_LOCATION_CLOSE_TO_EXCEEDING_LIMITS message has been sent,

and the audited PTC critical asset is identified to be within 1.5 meters of its identified location along the track centerline in the PTC track database.

SS_PM, 3.6-13 – Alert Retraction: PTC Asset Warning – Updated Track Database
The Process Management subsystem shall send an ASSET_LOCATION_CLOSE_TO_EXCEEDING_LIMITS retraction message to the back office if an ASSET_LOCATION_CLOSE_TO_EXCEEDING_LIMITS alert message has been sent for a PTC critical asset and a PTC Track Data Team user overrides the audit result.

SS_PM, 3.6-14 – Alert Retraction: Insufficient Data
The Process Management subsystem shall send an INSUFFICIENT_DATA retraction message to the back office if an INSUFFICIENT_DATA alert message has been sent for a PTC critical asset and new raw audit data becomes available verifying that PTC critical asset's location and attributes.

SS_PM, 3.6-15 – Alert Retraction: Audit Data Refresh Notification – New Raw Audit Data
The Process Management subsystem shall send an AUDIT_DATA_REFRESH_NOTIFICATION retraction message to the back office if an AUDIT_DATA_REFRESH_NOTIFICATION alert message has been sent for a PTC critical asset and new raw audit data becomes available for that PTC critical asset.

SS_PM, 3.6-16 – Alert Retraction: Audit Data Refresh Notification – Updated Track Database
The Process Management subsystem shall send an AUDIT_DATA_REFRESH_NOTIFICATION retraction message to the back office if an AUDIT_DATA_REFRESH_NOTIFICATION alert message has been sent for a PTC critical asset and an updated track database becomes available for that PTC critical asset.

SS_PM, 3.6-17 – Alert Retraction: Audit Expired – Completed Audit
The Process Management subsystem shall send an AUDIT_EXPIRED retraction message to the back office if an AUDIT_EXPIRED alert message has been sent for a PTC critical asset and an audit is completed for that PTC critical asset.

SS_PM, 3.6-18 – Alert Retraction: Audit Expired – Updated Track Database
The Process Management subsystem shall send an AUDIT_EXPIRED retraction message to the back office if an AUDIT_EXPIRED alert message has been sent for a PTC critical asset and an updated track database becomes available for that PTC critical asset.

4. Data Collection Requirements

SS_PM, 4-1 – Data Collection Locations
When a PTC critical asset(s) selected for audit management have reached their Audit Data Refresh Notification Date, the Process Management subsystem shall implement a TBD algorithm to determine data collection locations for the PTC critical asset(s) requiring updated raw audit data.

SS_PM, 4-2 – Data Collection Location Determination
The Process Management subsystem shall implement a TBD algorithm to determine data collection locations from asset audit groupings, for PTC critical assets selected for audit management.

SS_PM, 4-3 – Data Collection Platform Locations
The Process Management subsystem shall accept and store the location of data collection platforms.

SS_PM, 4-4 – Data Collection Locations: Asset Assignment
When a new data collection location is determined, the Process Management subsystem shall implement a TBD algorithm to assign the data collection location to a data collection platform.

SS_PM, 4-5 – Data Collection Subsystem: Data Collection Locations
If new data collection locations are available for a data collection asset, the Process Management subsystem shall provide data collection locations to the data collection platform, when a communication path is available, or becomes available.

SS_PM, 4-6 – Reference Data - Data Collection Locations
When the Data Collection subsystem requests a list of reference data for a data collection location, the Process Management subsystem shall provide a list of reference data available for each PTC critical asset selected for audit management, contained within the data collection locations.

SS_PM, 4-7 – Data Collection Subsystem: Current Reference Data
When reference data is transferred to the Data Collection subsystem, the Process Management subsystem shall provide the most current version of reference data to the Data Collection Subsystem.

SS_PM, 4-8 – Raw Audit Data Storage
The Process Management subsystem shall store raw audit data in the data storage component.

5. Data Comparisons Requirements

SS_PM, 5-1 – Onboard Data Comparison Subsystem: Reference Data
When reference data is transferred to the Data Collection subsystem, the Process Management subsystem shall provide the most current version of reference data to the co-located onboard Data Comparison subsystem.

SS_PM, 5-2 – PTC Critical Asset Audit Priority
When raw audit data is received from the Data Collection subsystem, the Process Management subsystem shall generate an Audit Priority for each PTC critical asset selected for audit management, contained in the raw audit data, based on the proximity to the PTC critical asset's Audit Expiration Date.

SS_PM, 5-3 – Data Comparison Subsystem: Raw Audit Data
When Audit Priorities are assigned to PTC critical assets in a raw audit data file received from the Data Comparison subsystem, the Process Management subsystem shall transfer the raw audit data to the Data Comparison subsystem.

SS_PM, 5-4 – Data Comparison Subsystem: Audit Priority
When raw audit data is provided to the Data Comparison subsystem, the Process Management subsystem shall provide all Audit Priorities associated with the PTC critical assets to be audited.

SS_PM, 5-5 – Data Comparison Subsystem: Reference Data
When raw audit data is provided to the Data Comparison subsystem, the Process Management subsystem shall provide all reference data associated with the PTC critical assets to be audited.

SS_PM, 5-6 – Audit Result Storage
The Process Management subsystem shall store audit results in the data storage component.

6. Interface Requirements

SS_PM, 6-1 – Data Collection Subsystem Interface
The Process Management subsystem shall implement the interface to the Data Collection subsystem defined in "Positive Train Control (PTC) Track Data Auditing System (TDAS) – Data Collection Subsystem-Process Management Subsystem Interface Control Document v 1.0."

SS_PM, 6-2 – Data Comparison Subsystem Interface
The Process Management subsystem shall implement the interface to the Data Comparison subsystem defined in the "Positive Train Control (PTC) Track Data Auditing System (TDAS) – Process Management Subsystem-Data Comparison Subsystem Interface Control Document v 1.0."

SS_PM, 6-3 – Back Office Interface
The Process Management subsystem shall implement the interface to the railroad back office defined in the "Positive Train Control (PTC) Track Data Auditing System (TDAS) – Process Management Subsystem-Railroad Back Office Interface Control Document v 1.0."

SS_PM, 6-4 – User Interface
The Process Management subsystem shall implement a user interface to allow users to interact with the system as specified throughout this specification.

SS_PM, 6-5 – Interface: Audit Result Override
The Process Management subsystem shall include an interface to support override of audit results for PTC critical assets selected for audit management, by a PTC Track Data Team user.

Appendix E.
Positive Train Control (PTC) Track Data Auditing System (TDAS): Data Collection Subsystem Requirements Specification v 1.0

Data Collection Subsystem Requirements Specification

1. Definitions

Table E 1. Definitions

Term	Definition
Asset Audit Grouping	Grouping of PTC critical assets during audit data comparison, ranging from individual assets to all assets within a track database
Audit	Process of comparing raw audit data against reference data and determining if the data corresponds
Audit Asset Location	Coordinates of a PTC critical asset as determined from the raw audit data
Audit Cycle Duration	Configurable number of days between the audit date and the audit expiration date
Audit Data Collection Date	Date raw audit data was collected
Audit Data Refresh Duration	Configurable number of days between the audit expiration date and the audit data refresh notification date
Audit Data Refresh Notification Date	Date beyond the latest raw audit data collection date at which a notification will be sent indicating new raw audit data is needed
Audit Date	Date that the raw audit data associated with a completed audit was collected
Audit Expiration Date	Date by which a PTC critical asset must be audited
Audit Management	Process of tracking audits, prioritizing and scheduling audits, generating reports, and providing alerts
Audit Parameters	Parameters related to management of the audit process, which at a minimum, include: Audit Scheduling Parameters, alert and report configurations, asset audit grouping configurations
Audit Priority	Variable assigned to a PTC critical asset identifying its priority to be audited, based on its proximity to its Audit Expiration date
Audit Process	Overall process of collecting raw audit data, comparing raw audit data against reference data, and updating/reporting audit status

Term	Definition

Audit Result	Result of the comparison between raw audit data and reference data for an individual PTC critical asset. Set to one of three possible results:
	• Pass:
	  ○ Location of a PTC critical asset as obtained from raw audit data is within an established horizontal accuracy along-track of the location specified in the track database and additional reference data, and
	  ○ Critical attributes of the asset as obtained from raw audit data are determined to match the critical attributes specified in the track database and additional reference data
	• Exception:
	  ○ Location of PTC critical asset as obtained from raw audit data and reference data is not within an established distance along-track of the location specified in the track database and additional reference data, or
	  ○ Critical attributes of the asset are determined not to match the critical attributes specified in the track database and additional reference data
	• Insufficient data: location and/or critical attributes of PTC critical asset as obtained from raw audit data could not be reliably verified

Audit Scheduling Parameters	The subset of Audit Parameters related specifically to the scheduling of audit data collection and data comparison, which may include: auditing PTC critical asset locations, audit groups, audit durations, Audit Priority, etc.
Audit Status	Information pertaining to the raw audit data collection date, audit date, audit data refresh notification date, audit expiration date, and result of last audit
Audit Warning	Alert generated if a PTC critical asset exceeds an established distance along-track from the location stored in the track database
Block Offset	Track referenced coordinate frame with positions relative to the beginning of a block within a track database
Data Collection Parameters	Parameters related to data collection, which may include: collection rates, resolution, timing, etc.
Data Collection Location	Locations over which the Data Collection subsystem begins and ends continuous collection of data
Data Comparison Parameters	Parameters related to data comparison, such as those related to error tolerances, identification confidences, etc.

Term	Definition
Data Storage Parameters	Parameters related to data storage, such as the amount of raw audit data to retain for PTC critical assets, frequency with which to store new raw audit data, quantity of separate raw audit data collections to store for a single asset
Georeferenced	Referenced to a coordinate frame relative to the earth's surface
Image Data	Data including LiDAR point clouds, video, and still image data
LiDAR	A laser-based, remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light.
Machine Vision Sensor	A sensor capable of imaging objects to support machine vision applications.
Opportunistic Data Collection	The collection of raw audit data from equipment mounted on vehicles conducting revenue service operations
Positive Train Control (PTC)	A form of train control where train movement authorities and speed limits are transmitted electronically and automatically enforced to prevent violations.
PTC Critical Asset	PTC equipment which if destroyed, degraded, relocated, or otherwise rendered unavailable, would affect the safety, reliability or operability of the railroad
PTC Critical Asset Validation Date	Date on which the location and critical attributes of an individual PTC critical asset was validated
PTC Critical Asset Survey Point	A reference point on a PTC critical asset used to represent the location and/or bounds of the asset.
Raw Audit Data	Data collected during audit process; to be compared against reference data
Reference Data	Data related to a PTC critical asset used as a reference for comparison against when conducting an audit (e.g., data contained within the track database, georeferenced data that has been validated against the track database, or relative location information from a referenced object).
System Update	The process of configuring and modifying system parameters
Targeted Data Collection	Data collection performed as a result of a target order from the Process Management subsystem

Term	Definition
Track Database	Onboard track data file, or subdivision file, targeted for use with the onboard system, as defined in the current version of AAR MSRP K-6, S-9503
Track Database Initialization	The process of adding track databases and corresponding PTC critical asset data to TDAS for the first time
Track Database Update	The modification of track databases and corresponding PTC critical asset data which has already been uploaded to TDAS
Reference Data Validation Date	Date on which reference data was validated

2. PTC Critical Assets and Attributes Definitions

Table E 2. PTC Critical Assets and Attributes

PTC Critical Assets	Attributes
Track centerline	
Integer mileposts, milepost signs	Sign text (optional)
Signals	Direction of signal Type of signal Signal graphic
Crossings, road crossings at grade	
Switches	Turnout leg Switch orientation
Permanent speed restrictions, speed signs	Sign text (optional)
Track detection circuit limits in non-signaled territory	
Inside switches equipped with switch circuit controllers	
Method of operation signs	Sign text (optional)
Derails	

3. Introduction

This document specifies the requirements for the Data Collection subsystem of the Track Data Auditing System (TDAS). The Data Collection subsystem provides the means to procure audit data for the audit management process, and includes capabilities to:

1. Collect raw audit data
2. Support user configuration of data collection parameters

In context of the audit process, the Data Collection subsystem is provided with reference data, from the Process Management subsystem, necessary to identify the Positive Train Control (PTC) critical assets and verify their location and critical attributes. This reference data may include:

- Data contained in the track database file
- PTC critical asset location (i.e., coordinates, station/offset)
- PTC critical asset type
- PTC data source ID
- Image data
- Offsets from PTC critical asset survey points which cannot be measured directly
- Geographical boundaries containing targeted PTC critical assets

The Audit Data collection team or automated Data Collection subsystem collects and provides raw georeferenced PTC critical asset image data that is date and time stamped to the Process Management subsystem or Data Comparison subsystem, depending on the specific implementation of the overall TDAS.

The collection of raw audit data can be a manual or automated process. The automated Data Collection subsystem may be implemented on a number of different vehicle types, including locomotives, track inspection vehicles, and dedicated track database data collection vehicles, or include manual data collection via field survey crews. Operation of the automated Data Collection subsystem requires little or no input from users and can be operated by minimally trained railroad personnel.

There can be significant variation in placement, size, orientation, and configuration of PTC critical assets. PTC critical assets may be located between rails, alongside the track, on adjacent tracks, or span across multiple tracks above rail. Furthermore, some PTC critical assets and their critical attributes are directionally specific.

Data capture can be performed continuously over a specified region, or only occur when collecting data for a specific asset, depending on how the Data Collection subsystem is implemented. Some examples of when these options may be utilized include:

- Continuously upon initialization of audit in the case of targeted data collection for an entire subdivision
- Intermittently in the case of targeted data collection, asset by asset (e.g., with a field survey crew)

- Continuously over specified regions in the case of opportunistic data collection

Data required by the Data Collection subsystem prior to performing an audit is dependent on whether data is collected intermittently at the assets themselves, or continuously over a region. The data collection subsystem requires location information for individual assets or the boundaries of the regions it will collect data within. In addition to data collected for determination of asset location, image data must also be collected to identify and compare critical attributes of assets to reference data.

The capabilities of the data comparison subsystem will contribute to the final requirements for the data collection subsystem capabilities with regard to data quality. Images must be sufficient to identify assets, locate them within required tolerances, and perform comparison of critical attributes to reference data. Data quality will be affected by, and drive the following parameters:

- Data collection subsystem resolution
- Vehicle speed
- Accuracy requirements of the railroad
- Data compression and storage methods

Data quality requirements will be further refined in conjunction with the development of the Data Comparison subsystem requirements.

3.1 Purpose

This document specifies the requirements for the TDAS Data Collection subsystem, including:

1. Data collection requirements related to:
   1.1 Data quality
   1.2 Hardware support requirements
2. Subsystem interface requirements

3.2 Applicable Documents

The following documents are applicable to the extent they are referenced in the text of this specification:

1. PTC Critical Asset Track Data Auditing System: System Description and Operational Concept v 2.0
2. Positive Train Control (PTC) Track Data Auditing System (TDAS) – System Requirements Specification v 2.0
3. Positive Train Control (PTC) Track Data Auditing System (TDAS) – Data Collection Subsystem-Process Management Subsystem Interface Control Document v 1.0
4. Positive Train Control (PTC) Track Data Auditing System (TDAS) – Data Collection Subsystem-Data Comparison Subsystem Interface Control Document v 1.0

3.3 User Classes

Table E 3 defines the user classes referenced in Section 4.

Table E 3. TDAS User Classes

User	Functions
PTC Track Data Team	• Determine configurable parameters of TDAS • Oversee TDAS and the auditing process • Oversee track database initialization and track database updates • Manage alerts, audit exceptions, and other anomalies
Audit Data Collection Team	• Manage collection of raw audit data • Oversee transfer of raw audit data to the data storage component • Schedule targeted collection of raw audit data, as appropriate/required • Perform raw audit data collection (if/when raw audit data collection is done manually)
Audit Comparison Team	• Compare raw audit data against reference data (if processing of data is done manually in the back office) • Oversee processing of raw audit data against reference data (if processing of data is done automatically)
TDAS Maintenance Team	• Implement updates or changes to TDAS • Perform TDAS routine maintenance • Troubleshoot TDAS failures

4. Subsystem Requirements

4.1 Raw Audit Data Collection Requirements

The Data Collection subsystem may be implemented on the following platforms:

- Ground crew
- Locomotive
- Hi-rail vehicle
- Rail car
- Unmanned aerial system

Note: Required platform(s) the Data Collection subsystem must support are located in Appendix E.1.

SS_DCL, 4.1-1 – Automated Raw Audit Data Collection
The Data Collection subsystem shall be capable of automated raw audit data collection.

Note: Automated raw audit data collection is the collection of data for assigned assets without input from operators.

SS_DCL, 4.1-2 – Manual Raw Audit Data Collection
The Data Collection subsystem shall be capable of manual raw audit data collection.

Note: Manual raw audit data collection is collection of raw audit data performed by Audit Data Collection Team personnel.

SS_DCL, 4.1-3 – Collection of Georeferenced Image Data
When collecting raw audit data, the Data Collection subsystem shall collect georeferenced image data for all PTC critical assets selected for audit management, excluding the track centerline.

SS_DCL, 4.1-4 – Collection of Track Centerline Coordinates
When collecting raw audit data, the Data Collection subsystem shall collect georeferenced coordinates for the track centerline at a railroad defined frequency.

SS_DCL, 4.1-5 – Collection of Location History
When collecting raw audit data, the Data Collection subsystem shall record its on-track location history at a railroad defined frequency.

Note: Since the track centerline is a PTC critical asset, location history is subject to the same accuracy requirements as all other PTC critical assets.

SS_DCL, 4.1-6 – Raw Audit Data Date and Time
The Data Collection subsystem shall annotate georeferenced raw audit data collected with the collection date and time.

SS_DCL, 4.1-7 – Data Collection: Position Accuracy
The Data Collection subsystem shall capture raw audit data sufficient to determine the asset position within 3.5 feet.

SS_DCL, 4.1-8 – Data Collection: Critical Feature Identification
The Data Collection subsystem shall capture raw audit data sufficient to verify critical attributes.

Note: The list of critical assets and attributes is provided in Table E 2.

SS_DCL, 4.1-9 – Data Collection: Speed
When collecting raw audit data, rail-based implementations of the Data Collection subsystem shall be capable of capturing all raw audit data necessary to complete an audit of all critical assets, and critical attributes at vehicle velocities ranging from 0 mph through 79 mph.

SS_DCL, 4.1-10 – Data Collection: Single Pass
When collecting raw audit data, the Data Collection subsystem shall be capable of capturing all raw audit data necessary to complete an audit of all critical assets and critical attributes in one pass.

SS_DCL, 4.1-11 – Data Collection: Vertical Distance
When collecting raw audit data, the Data Collection subsystem shall be capable of capturing all raw audit data necessary to complete an audit of all critical assets, and critical attributes at a vertical distance of 0-50 feet above rail.

SS_DCL, 4.1-12 – Data Collection: Lateral Distance
When collecting raw audit data, the Data Collection subsystem shall be capable of capturing all raw audit data necessary to complete an audit of all critical assets, and critical attributes at a lateral distance of 0-50 feet on either side of the track centerline.

SS_DCL, 4.1-13 – Data Collection: Timing
When collecting raw audit data, the Data Collection subsystem shall begin data collection upon approach to PTC track or a PTC critical asset with sufficient time and distance to collect the required raw audit data for that PTC track or PTC critical asset.

4.2 Interface Requirements

SS_DCL, 4.2-1 – Process Management Subsystem Interface
The Data Collection subsystem shall implement the interface to the Process Management subsystem defined in "Positive Train Control (PTC) Track Data Auditing System (TDAS) – Data Collection Subsystem-Process Management Subsystem Interface Control Document v 1.0."

SS_DCL, 4.2-2 – Data Comparison Subsystem Interface
If configured accordingly, the Data Collection subsystem shall implement the interface to the Data Comparison subsystem defined in the "Positive Train Control (PTC) Track Data Auditing System (TDAS) – Data Collection Subsystem-Data Comparison Subsystem Interface Control Document v 1.0."

SS_DCL, 4.2-3 – Process Management Subsystem: Exchange Raw Audit Data and Reference Data
The Data Collection subsystem shall be capable of initiating a connection with the Process Management subsystem to request reference data, data collection locations, or to provide current position, and raw audit data.

SS_DCL, 4.2-4 – Process Management Subsystem: Raw Audit Data
Upon completion of data collection, when configured for transfer of raw audit data to the Process Management subsystem, the Data Collection subsystem shall send raw audit data to the Process Management subsystem, when a communications path is or becomes available.

SS_DCL, 4.2-5 – Data Comparison Subsystem: Exchange Raw Audit Data and Reference Data
The Data Collection subsystem shall be capable of initiating a connection with the Data Comparison subsystem to provide reference data and raw audit data.

SS_DCL, 4.2-6 – Data Comparison Subsystem: Raw Audit Data
Upon completion of data collection, when configured for transfer of raw audit data to the Data Comparison subsystem, the Data Collection subsystem shall send raw audit data to the Data Comparison subsystem, when a communications path is or becomes available.

SS_DCL, 4.2-7 – Data Comparison Subsystem: Reference Data
Upon completion of data collection, when configured for transfer of reference data to Data Comparison subsystem, the Data Collection subsystem shall send all reference data associated with the raw audit data, to the Data Comparison subsystem, when a communications path is or becomes available.

SS_DCL, 4.2-8 – External Storage Device: Raw Audit Data Transfer
The Data Collection subsystem shall provide an interface for a user to download raw audit data to external storage devices.

SS_DCL, 4.2-9 – External Storage Device: Reference Data Transfer
The Data Collection subsystem shall provide an interface for a user to upload reference data to external storage devices, when a connection to the Process Management subsystem is unavailable.

SS_DCL, 4.2-10 – Audit Data Collection Team User: Data Collection Locations
The Data Collection subsystem shall provide a user interface for Audit Data Collection Team users to enter locations to begin and end data collection along a route, to override locations provided by the Process Management subsystem or when a connection to the Process Management subsystem is unavailable.

SS_DCL, 4.2-11 – Data Collection Subsystem Users
The Data Collection subsystem shall not require user input outside of what is detailed in this specification and from anyone other than a Data Collection team user.

4.3 Data Collection Initialization

Data collection initialization occurs upon receipt of new data collection locations from the Process Management subsystem.

SS_DCL, 4.3-1 – Data Collection Locations: Process Management Subsystem
The Data Collection subsystem shall request data collection locations from the Process Management subsystem identifying where to begin and end data collection along a route, at a railroad defined frequency.

SS_DCL, 4.3-2 – Process Management Subsystem: Request Reference Data List
When data collection is initialized, the Data Collection subsystem shall request a list of required reference data from the Process Management subsystem.

Note: The reference data list contains identifying information such as filenames and versions of required reference data.

SS_DCL, 4.3-3 – Missing Reference Data
When data collection is initialized, if reference data specified by the Process Management subsystem is not currently stored by the Data Collection subsystem, the Data Collection subsystem shall request the missing reference data from the Process Management subsystem.

SS_DCL, 4.3-4 – Current Reference Data
When data collection is initialized, if the current version of reference data specified by the Process Management subsystem is different from the version currently stored by the Data Collection subsystem, the Data Collection subsystem shall request the updated reference data from the Process Management subsystem.

4.4 Data Collection Reference Data Requirements

SS_DCL, 4.4-1 – Track Database
The Data Collection subsystem shall use the track database to determine the location of PTC critical assets.

SS_DCL, 4.4-2 – Data Collection Location Determination: Process Management Subsystem
When the Data Collection subsystem has received a data collection location from the Process Management subsystem, and the location of the Data Collection subsystem is within the location received, the Data Collection subsystem shall begin raw audit data collection.

Note: Data collection locations refers to locations along a route in which the Data Collection subsystem begins and ends continuous collection of data.

SS_DCL, 4.4-3 – Data Collection Location Determination: Data Collection Subsystem
When collecting data opportunistically, the Data Collection subsystem shall be capable of utilizing reference data to determine data collection locations.

Note: Opportunistic data collection is the collection of raw audit data from equipment mounted on vehicles conducting revenue service operations.

4.5 Configuration Requirements

SS_DCL, 4.5-1 – Configuration: Data Collection Parameters
The Data Collection subsystem shall provide an interface for user-configuration of data collection parameters.

Appendix E.1.
Data Collection Subsystem Requirements – Additional Requirements

Data Collection Subsystem Requirements – Additional Requirements

1. Additional Requirements

1.1. Operating Speeds

- The operating speeds are as follows for each platform listed:
- Locomotive: 0–79 mph
- Railcar: 0–79 mph
- Hi-Rail: 0–45 mph
- Unmanned Aerial System: 5–60 mph

1.2. Required Platforms

The Data Collection subsystem must the following platforms:

Appendix F.
Positive Train Control (PTC) Track Data Auditing System (TDAS): Data Collection Subsystem-Data Comparison Subsystem Interface Control Document v 1.0

Data Collection Subsystem-Data Comparison Subsystem Interface Control Document

1. Introduction

This document defines the message interface between the Track Data Auditing System (TDAS) Data Collection subsystem and the Data Comparison subsystem. Figure F 1 depicts the TDAS architecture and highlights the interface defined within this document. In this message flow, the Data Collection subsystem and the Data Comparison subsystems are co-located.

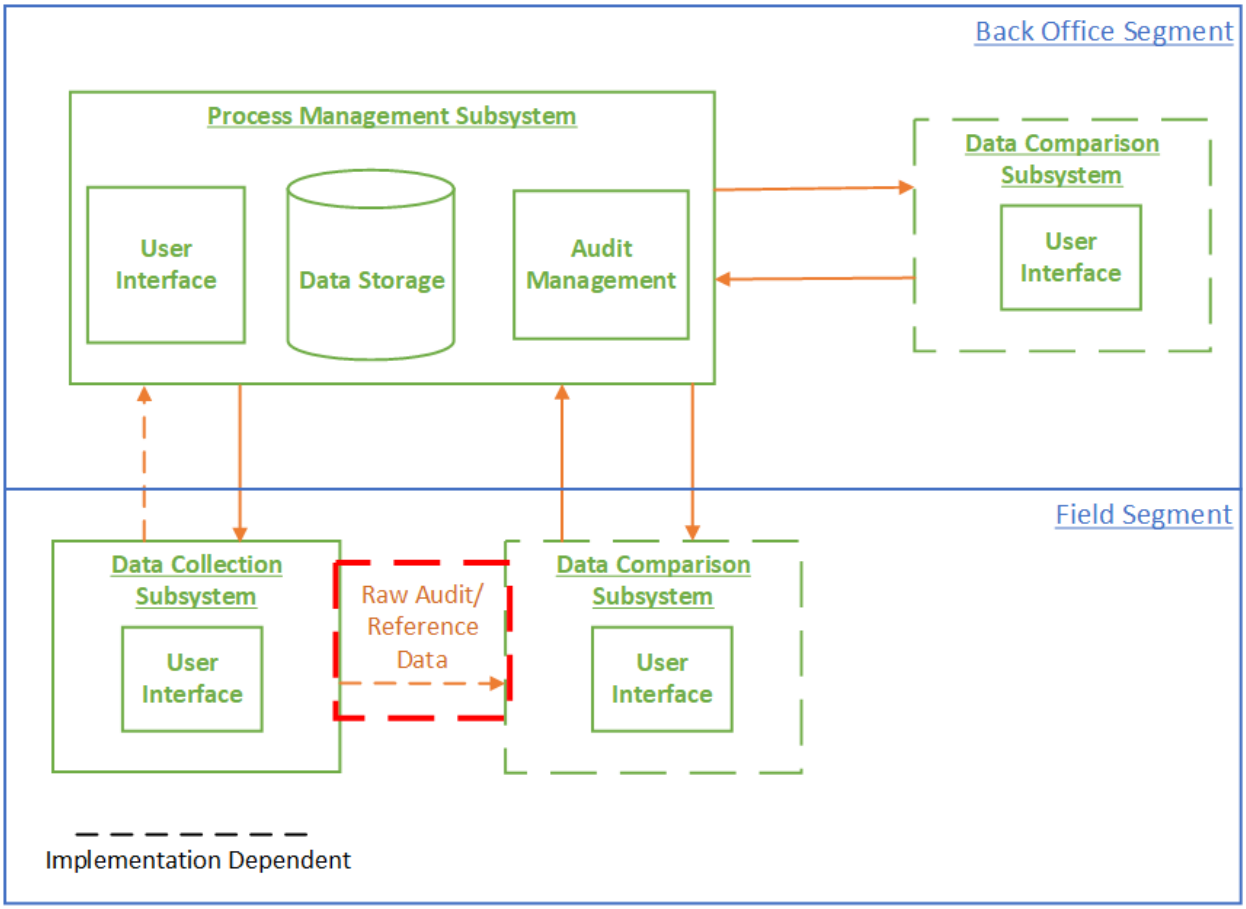

Figure F 1. Data Collection Subsystem and Data Comparison Subsystem Interface

2. Applicable Documents

The following documents are applicable to the extent that they are referenced herein.

- Positive Train Control (PTC) Track Data Auditing System (TDAS) - System Requirements Specification v 1.0
- Positive Train Control (PTC) Track Data Auditing System (TDAS) - Data Collection Subsystem Requirements Specification v 1.0
- Message Detail
- Additional interface requirements are contained in Appendix F.1.

2.1 General Message Assumptions

The following do not include the header and CRC parts of the message.

- Message fields may be fixed field length or variable, as specified in this document
- All message data type is specified in the message
- All time fields are specified in Universal Time Coordinated (UTC)
- Each message is self-contained. All data required for processing a message is contained in the message itself, not in multiple messages.
- All Character/Alpha fields are left-justified and padded with spaces if necessary
- All Numeric fields are right-justified and prefixed with leading zeroes if needed
- All Milepost modifier fields are blank if not applicable

The “Type” column abbreviations are presented in Table F 1:

Table F 1. “Type” Column Abbreviations

“Type” column abbreviations	Meaning
B	Binary numeric data for byte length specified in size
A	American Standard Code for Information Interchange (ASCII) alpha or alpha/numeric data
Zb	UTC–Binary date and time field of 7 bytes in the form of CC - 1 byte, YY - 1 byte, MM DD HH MM SS – 1 byte each
Y	Yes or No field with data of either ASCII Y or ASCII N

2.2 Messages Between Data Collection Subsystem and Data Comparison Subsystem

Table F 1 specifies the messages that are sent from the Data Collection subsystem (DCL) to the Data Comparison subsystem (DC) and Table F 2 specifies the messages that are sent from the DC to the DCL. Figure F 2 and Figure F 3 show the sequence of messages sent between the DCL and the DC for each type of data exchange.

Table F 2. Messages from DCL

Message Type	Version	Description	Source	Destination
5000	1	Initiate/Terminate Connection	DCL	DC

Table F 3. Messages from DC

Message Type	Version	Description	Source	Destination
7000	1	Confirm Initiate/Terminate Connection	DC	DCL

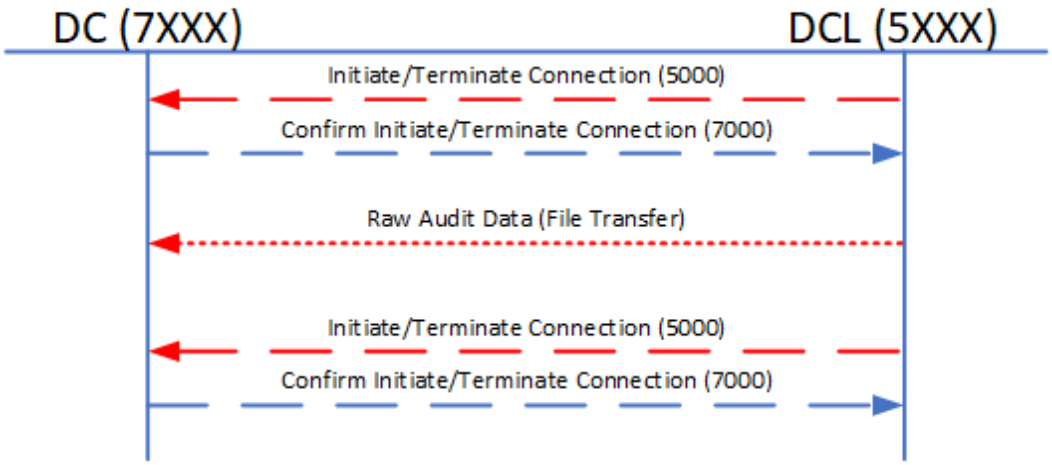

Figure F 2. Message Diagram – Raw Audit Data

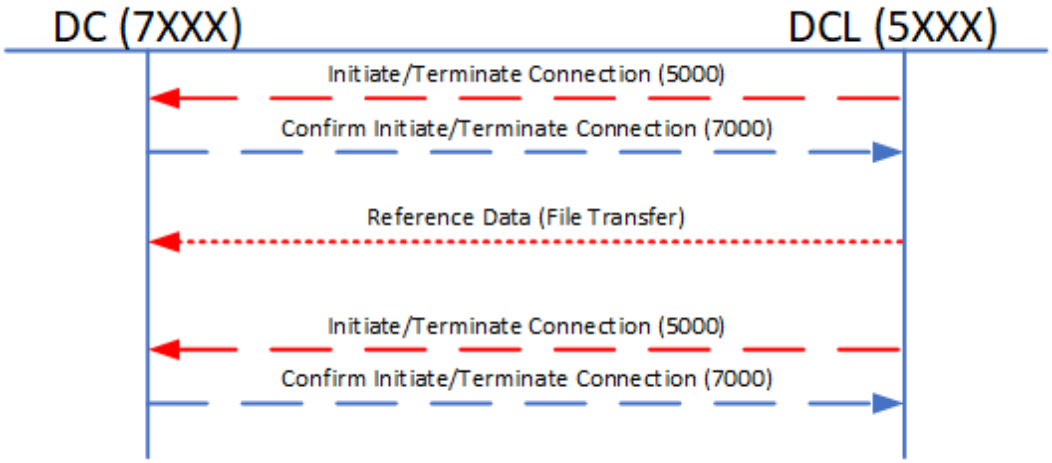

Figure F 3. Message Diagram - Reference Data

2.3 Message Descriptions Between Data Collection Subsystem and Data Comparison Subsystem

2.3.1 Initiate/Terminate Connection (5000)

This message is sent from the DCL to the DC to initiate/terminate connection. The subsystem authenticates the connection and responds with a Confirm Initiate/Terminate Connection message. Table F 4 details the message structure.

Table F 4. Initiate/Terminate Connection Message Structure

ID	Field	Size (bytes)	Type	Value	Description
1.	Message ID	2	B	5000	Message ID
2.	Message Version	1	B		Message version number
3.	DCL Asset ID	20	A		Asset tag of equipment
4.	DCL Software Revision	20	A	–	DCL software revision
5.	Date Time	7	Zb		CCYYMMDDHHMMSS
6.	Reason	1	B	ENUM	1 = Initialize connection 2 = Terminate connection
7.	Message Coordination Number	4	B		Message sequence number hashed with time for each new conversation

2.3.2 Confirm Initiate/Terminate Connection (7000)

This message is sent from the DC in response to an Initiate/Terminate Connection message from the DCL. Table F 5 details the message structure.

Table F 5. Confirm Initiate/Terminate Connection Message Structure

ID	Field	Size (bytes)	Type	Value	Description
1.	Message ID	2	B	7000	Message ID
2.	Message Version	1	B		Message version number
3.	DC Asset ID	20	A		Asset tag of equipment
4.	Required Software Revision	20	A	–	Required DCL software revision
5.	Acceptance Status	1	B	ENUM	0 = Not used 1 = Not valid PM asset ID 2 = Invalid software version 3 = Other error
6.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation

Appendix F.1.
Railroad Specified Interface Requirements

The message interface utilizes a TCP/IP connection with SSL for authentication and encryption. File transfers are handled via SFTP.

Appendix G.
Positive Train Control (PTC) Track Data Auditing System (TDAS): Process Management Subsystem-Data Collection Subsystem Interface Control Document v 1.0

Process Management Subsystem-Data Collection Subsystem Interface Control Document

1. Introduction

This document defines the message interface between the Track Data Auditing System (TDAS) Process Management subsystem and the Data Collection subsystem. Figure G 1 depicts the TDAS architecture and highlights the interface defined within this document.

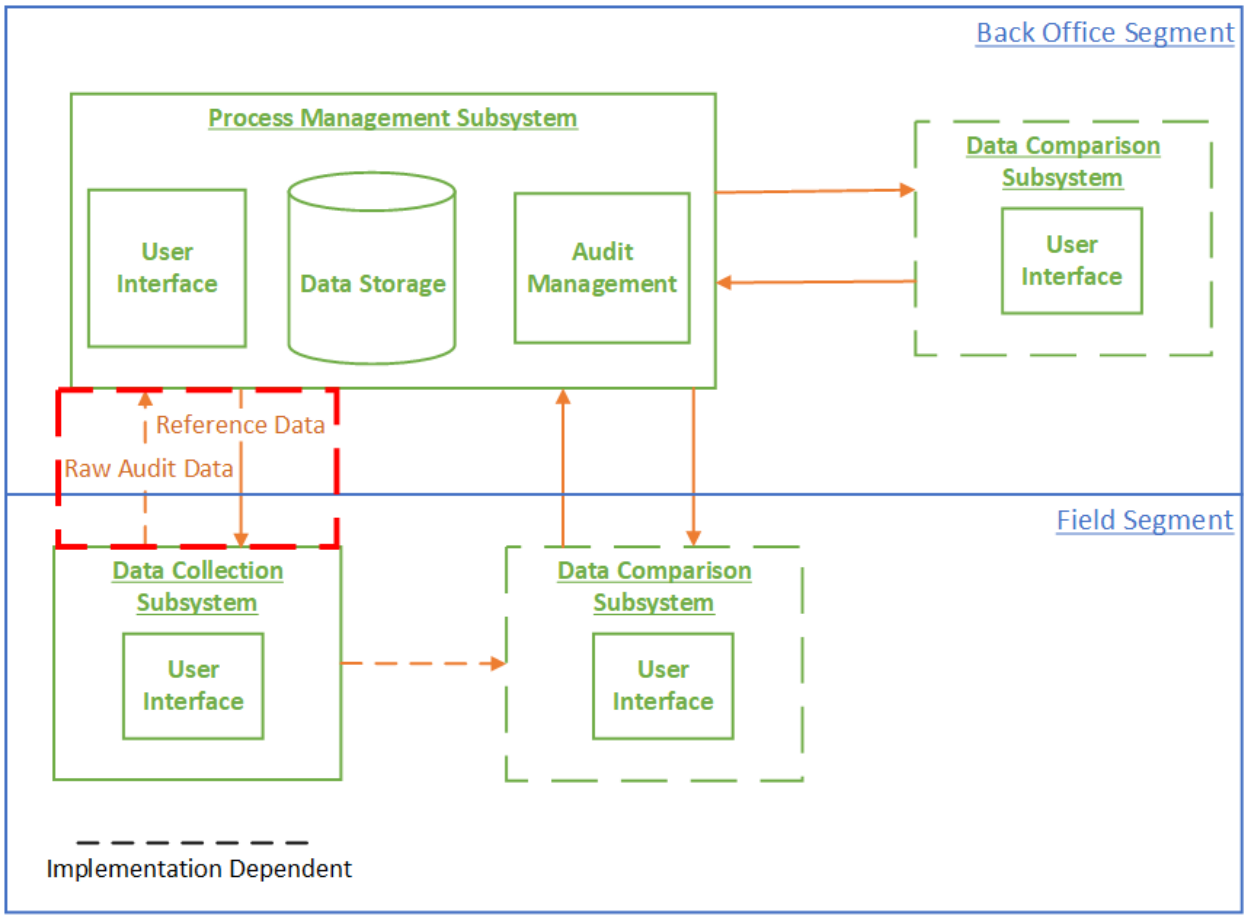

Figure G 1. Process Management Subsystem and Data Collection Subsystem Interface

1.1 Applicable Documents

The following documents are applicable to the extent that they are referenced herein.

- Positive Train Control (PTC)Track Data Auditing System (TDAS) - System Requirements Specification v 1.0
- Positive Train Control (PTC)Track Data Auditing System (TDAS) - Data Collection Subsystem Requirements Specification v 1.0

2. Message Details

Additional interface requirements are contained in Appendix G.1.

2.1 General Message Assumptions

The following do not include the header and CRC parts of the message:

- Message fields may be fixed field length or variable, as specified in this document.
- All message data type is specified in the message.
- All time fields are specified in UTC.
- Each message is self-contained. All data required for processing a message is contained in the message itself, not in multiple messages.
- All Character/Alpha fields are left-justified and padded with spaces if necessary.
- All Numeric fields are right-justified and prefixed with leading zeroes if needed.
- If applicable, message sizes are specified in the Size field.

The "Type" column abbreviations, shown in Table G 1, are as follows:

Table G 1. "Type" Column Abbreviations

"Type" column abbreviations	Meaning
B	Binary numeric data
A	ASCII alpha or alpha/numeric data
Zb	Universal Time Coordinated (UTC)–Binary date and time field of 7 bytes in the form of CC - 1 byte, YY - 1 byte, MM DD HH MM SS – 1 byte each
Y	Yes or No field with data of either ASCII Y or ASCII N

2.2 Messages Between Process Management Subsystem and Data Collection Subsystem

Table G 1 specifies the messages that are sent from the Data Collection subsystem (DCL) to the Process Management subsystem (PM) and Table G 2 specifies the messages that are sent from the PM to the DCL. Figure G 2 through Figure G 6 show the sequence of messages sent between the DCL and the PM for each type of data exchange.

Table G 2. Message from DCL

Message Type	Version	Description	Source	Destination
4000	1	Initiate/Terminate Connection	DCL	PM
4001	1	Confirm Initiate/Terminate Connection	DCL	PM
4010	1	Request Data Collection Locations	DCL	PM
4020	1	Request Reference Data List	DCL	PM
4030	1	Request Reference Data	DCL	PM
4040	1	DCL Asset Location	DCL	PM

Table G 3. Messages from PM

Message Type	Version	Description	Source	Destination
2000	1	Confirm Initiate/Terminate Connection	PM	DCL
2001	1	Initiate/Terminate Connection	PM	DCL
2010	1	Data Collection Locations	PM	DCL
2020	1	Reference Data List	PM	DCL
2040	1	Request DCL Asset Location	PM	DCL

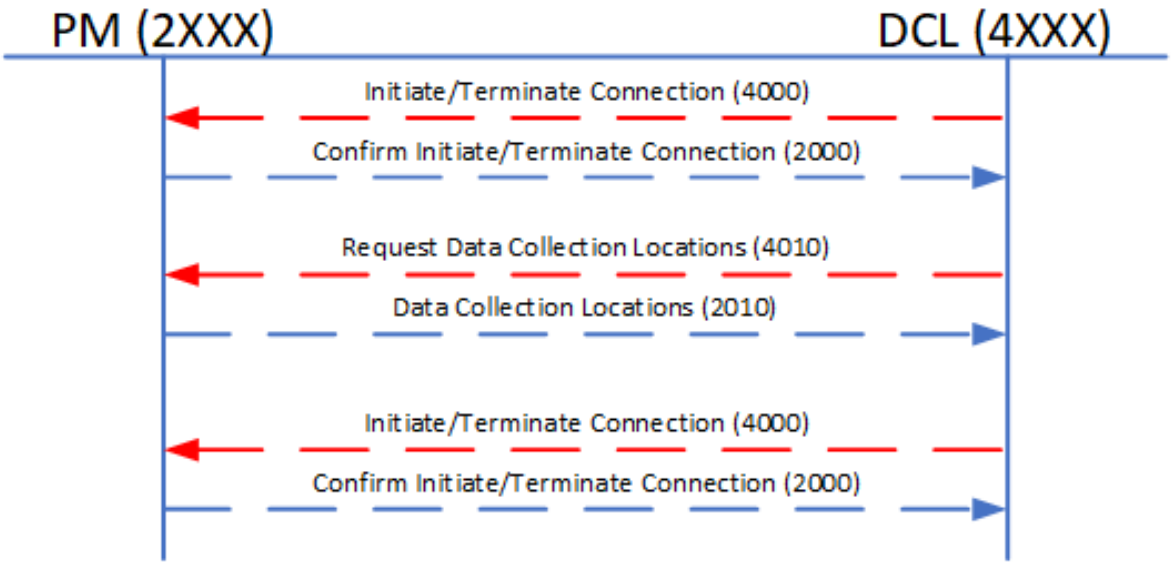

Figure G 2. Message Diagram - Data Collection Locations

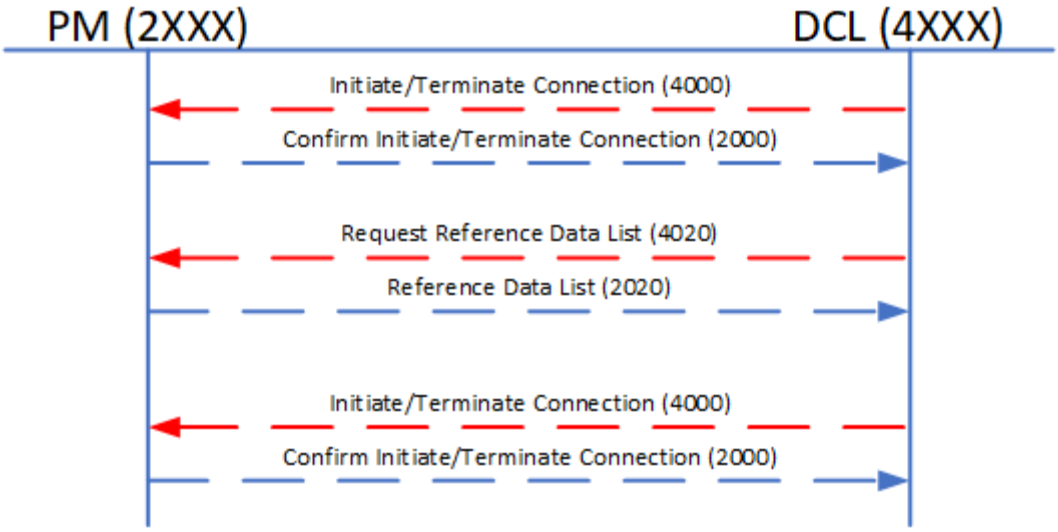

Figure G 3. Message Diagram - Reference Data List

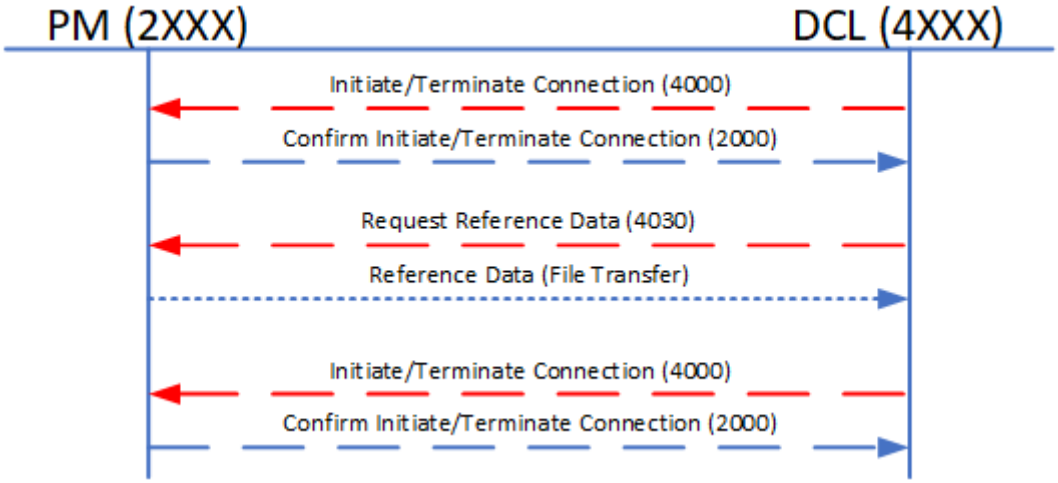

Figure G 4. Message Diagram - Reference Data

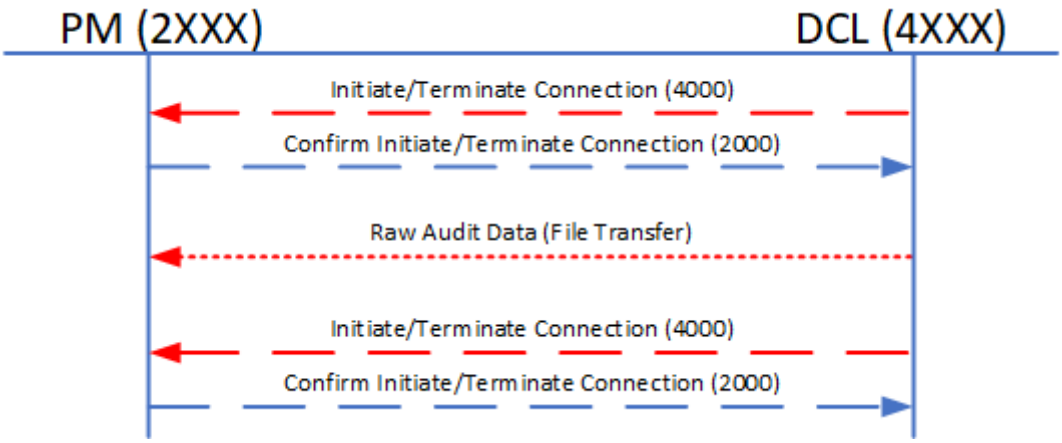

Figure G 5. Message Diagram - Raw Audit Data

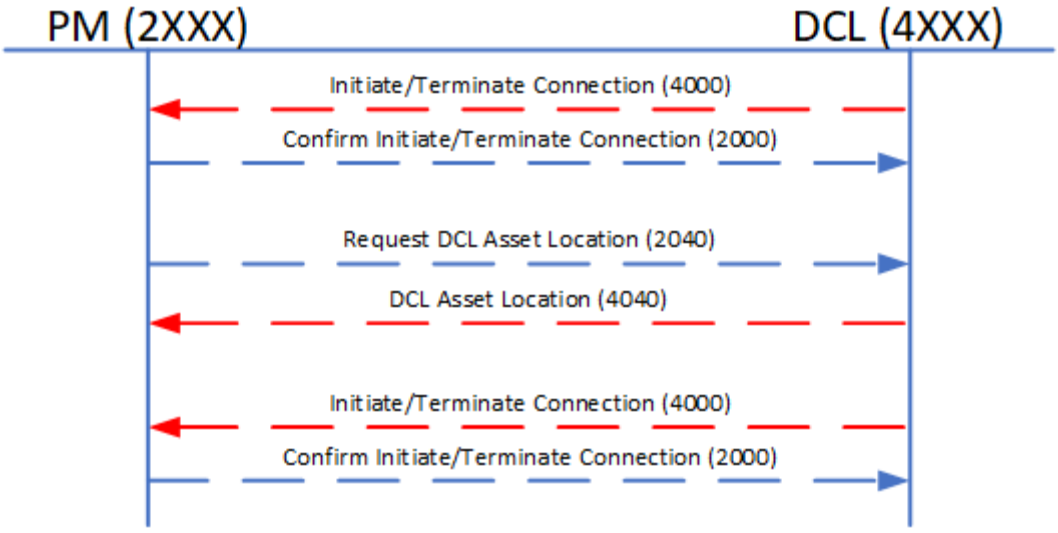

Figure G 6. Message Diagram - DCL Asset Location

2.3 Message Descriptions Between PM Subsystem and Data Collection Subsystem

2.3.1 Initiate/Terminate Connection (4000/2001)

This message is sent to initiate/terminate connection between subsystems. The responding subsystem authenticates the connection and responds with a Confirm Initiate/Terminate Connection message. Table G 4 details the message structure.

Table G 4. Initiate/Terminate Connection Message Structure

ID	Field	Size (bytes)	Type	Value	Description
1.	Message ID	2	B	-	Message ID

ID	Field	Size (bytes)	Type	Value	Description
2.	Message Version	1	B		Message version number
3.	Asset ID	20	A		Asset tag of equipment
4.	Software Revision	20	A	–	Subsystem software revision
5.	Date Time	7	Zb		CCYYMMDDHHMMSS
6.	Reason	1	B	ENUM	1 = Initialize connection 2 = Terminate connection
7.	Message Coordination Number	4	B		Message sequence number hashed with time for each new conversation

2.3.2 Confirm Initiate/Terminate Connection (2000/4001)

This message is sent in response to an Initiate/Terminate Connection message. Table G 5 details the message structure.

Table G 5. Confirm Initiate/Terminate Connection Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	-	Message ID
2.	Message Version	1	B		Message version number
3.	Asset ID	20	A		Asset tag of equipment
4.	Software Revision	20	A	–	Required software version
5.	Acceptance Status	1	B	ENUM	0 = Not used 1 = Not valid asset ID 2 = Invalid software version 3 = Other error
6.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation

2.3.3 Request Data Collection Locations (2010)

This message is sent from the DCL to the PM to request data collection locations. The PM responds with a Data Collection Locations message. Table G 6 details the message structure.

Table G 6. Request Data Collection Locations Message Structure

ID	Field	Size (bytes)	Type	Value	Description
1.	Message ID	2	B	2010	Message ID
2.	Message Version	1	B		Message version number
3.	DCL Asset ID	20	A		Asset tag of equipment
4.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation

2.3.4 Data Collection Locations (4010)

This message is sent from the PM to the DCL in response to a Request Data Collection Locations message. Data collection locations will be provided as a set of coordinates defining data collection location boundaries. Table G 7 details the message structure.

Table G 7. Data Collection Locations Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	4010	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Received Message ID	4	B	-	Message ID of message this message is acknowledging.
5.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
6.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivisions				
7.	Subdivision	25	A		Subdivision name
8.	Subdivision ID	25	A		Subdivision ID
9.	Subdivision File Revision Number	20	A		Subdivision file revision number
10.	Number Data Collection Locations	2	B		Number of data collection locations following
	Repeating Data Collection Locations for count in Number of Data Collection Locations				
11.	Data Collection Location ID	6	A		Data Collection Location ID
12.	Collection X Coordinate 1	4	B		ECEF X coordinate 1 of data collection location boundary. Signed binary. Precision

2.3.5 Request Reference Data List (4020)

This message is sent from the DCL to the PM to request the current reference data list. The PM responds with a Reference Data List message. Table G 8 details the message structure.

Table G 8. Request Reference Data List Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	4020	Message ID
2.	Message Version	1	B		Message version number
3.	DCL Asset ID	20	A		Asset tag of equipment
4.	Reason for Request	1	B	ENUM	0 = Not used 1 = Beginning data collection 2 = Manual Request
5.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation

2.3.6 Reference Data List (2020)

This message is sent from the PM to the DCL in response to a Request Reference Data List message. Table G 9 details the message structure.

Table G 9. Reference Data List Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	2020	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Received Message ID	4	B	-	Message ID of message this message is acknowledging.
5.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
6.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivisions				
7.	Subdivision	25	A		Subdivision Name
8.	Subdivision ID	25	A		Subdivision ID
9.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
10.	Number of Files	2	B		Number of subdivisions following
	Repeating Reference Data IDs for count in Number of Files				
11.	Reference Data ID	20	A		ID of reference data
12.	Reference Data File Name	40	A		File name and file type of reference data
	End of Repeating Reference Data IDs for count in Number of Files				

2.3.7 Request Reference Data (4030)

This message is sent from the DCL to the PM to request reference data from the Reference Data List message. The PM responds by providing the requested reference data files. Table G 10 details the message structure.

Table G 10. Request Reference Data Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	4030	Message ID
2.	Message Version	1	B		Message version number
3.	DCL Asset ID	20	A		Asset tag of equipment
4.	Received Message ID	4	B	-	Message ID of message this message is acknowledging.
5.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
6.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivision				
7.	Subdivision	25	A		Subdivision Name
8.	Subdivision ID	25	A		Subdivision ID
9.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
10.	Number of Files	2	B		Number of subdivisions following
	Repeating Reference Data IDs for count in Number of Files				
11.	Reference Data ID	20	A		ID of reference data
12.	Reference Data File Name	40	A		File name and file type of reference data
	End of Repeating Reference Data IDs for count in Number of Files				
	End of Repeating Subdivision IDs for count in Number of Subdivisions				

2.3.8 Request DCL Asset Location (2040)

This message is sent from the PM to the DCL to request data collection locations. The DCL responds with a DCL Asset Location message. Table G 11 details the message structure.

Table G 11. Request DCL Asset Location Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	2040	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation

2.3.9 DCL Asset Location (4040)

This message is sent from the DCL to the PM in response to a Request DCL Asset Location message. Table G 12 details the message structure.

Table G 12. DCL Asset Location Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	4040	Message ID
2.	Message Version	1	B		Message version number
3.	DCL Asset ID	20	A		Asset tag of equipment
4.	Received Message ID	4	B	-	Message ID of message this message is acknowledging.
5.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
6.	Asset Location Timestamp	7	Zb		Timestamp associated with the retrieval of DCL asset position. CCYYMMDDHHMMSS
7.	DCL X Coordinate	4	B		ECEF X coordinate of data collection subsystem asset. Signed binary. Precision measured in centimeters.

ID	Field	Size (Bytes)	Type	Value	Description
8.	DCL Y Coordinate	4	B		ECEF Y coordinate of data collection subsystem asset. Signed binary. Precision measured in centimeters.
9.	DCL Z Coordinate	4	B		ECEF Z coordinate of data collection subsystem asset. Signed binary. Precision measured in centimeters.

Appendix G.1.
Railroad Specified Interface Requirements

The message interface utilizes a TCP/IP connection with SSL for authentication and encryption. File transfers are handled via SFTP.

Appendix H.
Positive Train Control (PTC) Track Data Auditing System (TDAS): Process Management Subsystem-Railroad Back Office Interface Control Document v 1.0

Process Management Subsystem-Railroad Back Office Interface Control Document

1. Introduction

This document defines the message interface between the Track Data Auditing System (TDAS) Process Management (PM) subsystem and the railroad Back Office Server (BOS). The PM is located in the railroad back office as depicted in the TDAS architecture (Figure H 1).

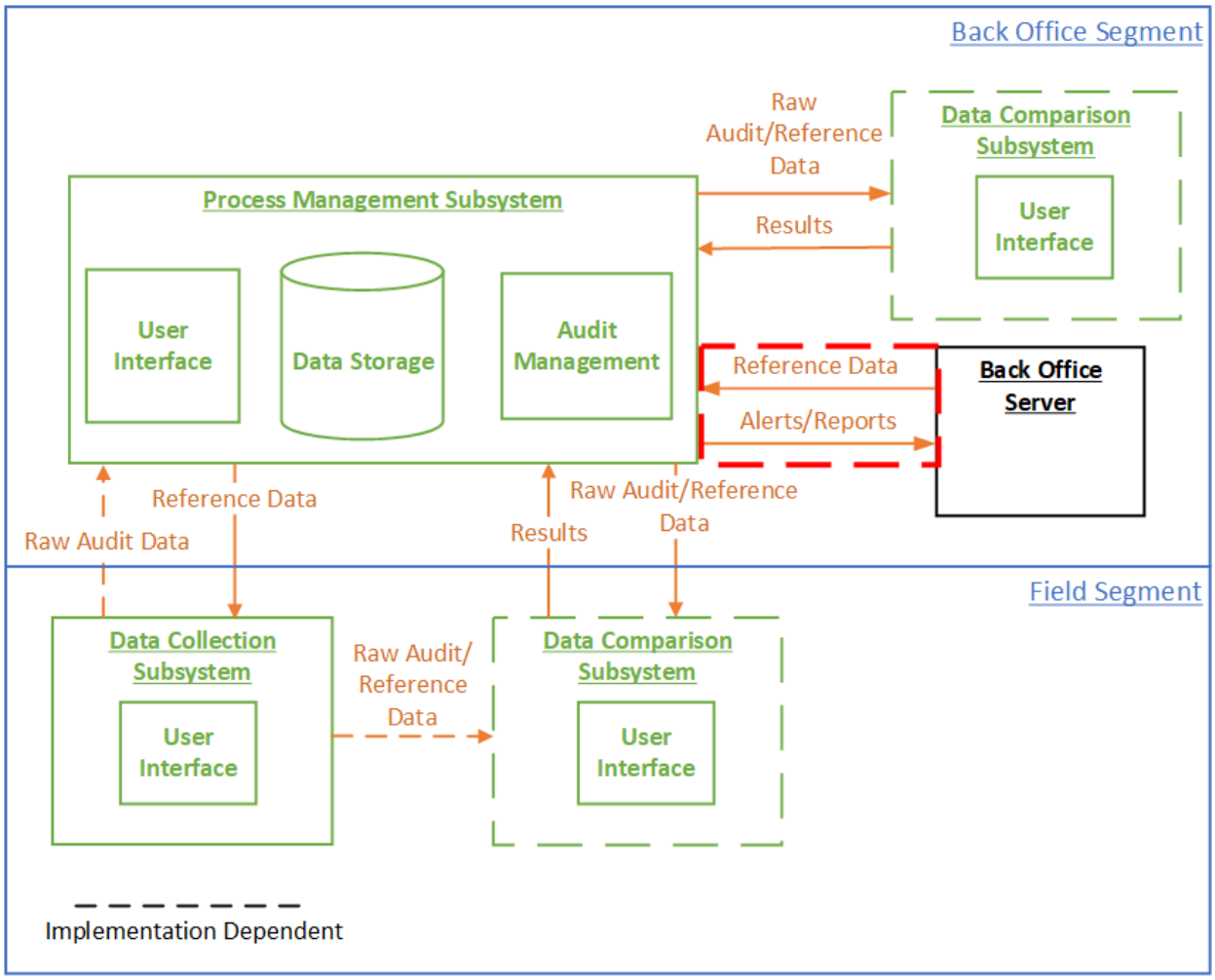

Figure H 1. PM Subsystem and BOS Interface

1.1 Applicable Documents

The following documents are applicable to the extent they are referenced in the text of this specification:

- Positive Train Control (PTC) Track Data Auditing System (TDAS) - System Requirements Specification v 2.0
- Positive Train Control (PTC) Track Data Auditing System (TDAS) - Process Management Subsystem Requirements Specification v 1.0

2. Message Details

Additional interface requirements are contained in Appendix H.1.

2.1 General Message Assumptions

The following do not include the header and CRC parts of the message:

- Message fields may be fixed field length or variable, as specified in this document
- All message data types are specified in the message definition
- All time fields are specified in Universal Time Coordinated (UTC)
- Each message is self-contained. All data required for processing a message is contained in the message itself, not in multiple messages.
- All Character/Alpha fields are left-justified and padded with spaces if necessary
- All Numeric fields are right-justified and prefixed with leading zeroes if needed
- If applicable, message sizes are specified in the Size field

The "Type" column abbreviations are shown in Table H 1:

Table H 1. "Type" Column Abbreviations

"Type" column abbreviations	Meaning
B	Binary numeric data
A	ASCII alpha or alpha/numeric data
Zb	UTC–Binary date and time field of 7 bytes in the form of CC - 1 byte, YY - 1 byte, MM DD HH MM SS – 1 byte each
Y	Yes or No field with data of either ASCII Y or ASCII N

2.2 Messages Between TDAS Process Management Subsystem and Back Office Service

Table H 1 specifies the messages that are sent from the PM to the BOS and Table H 2 specifies the messages that are sent from the BOS to the PM. Figure H 2 through Figure H 4 shows the sequence of messages sent between the DCL and the PM for data exchange.

Table H 2. Message from PM

Message Type	Version	Description	Source	Destination
1000	1	Initiate/Terminate Connection	PM	BOS
1010	1	Request Track Database List	PM	BOS
1020	1	Request Track Database	PM	BOS

Message Type	Version	Description	Source	Destination
1030	1	Audit Exception Alert/Retraction	PM	BOS
1040	1	Insufficient Data Alert/Retraction	PM	BOS
1050	1	Asset Location Close to Exceeding Limits Alert/Retraction	PM	BOS
1060	1	Audit Data Refresh Notification Alert/Retraction	PM	BOS
1070	1	Audit Expired Alert/Retraction	PM	BOS
1080	1	Reference Data Required Alert/Retraction	PM	BOS

Table H 3. Messages from BOS

Message Type	Version	Description	Source	Destination
9000	1	Confirm Initiate/Terminate Connection	BOS	PM
9010	1	Track Database List	BOS	PM

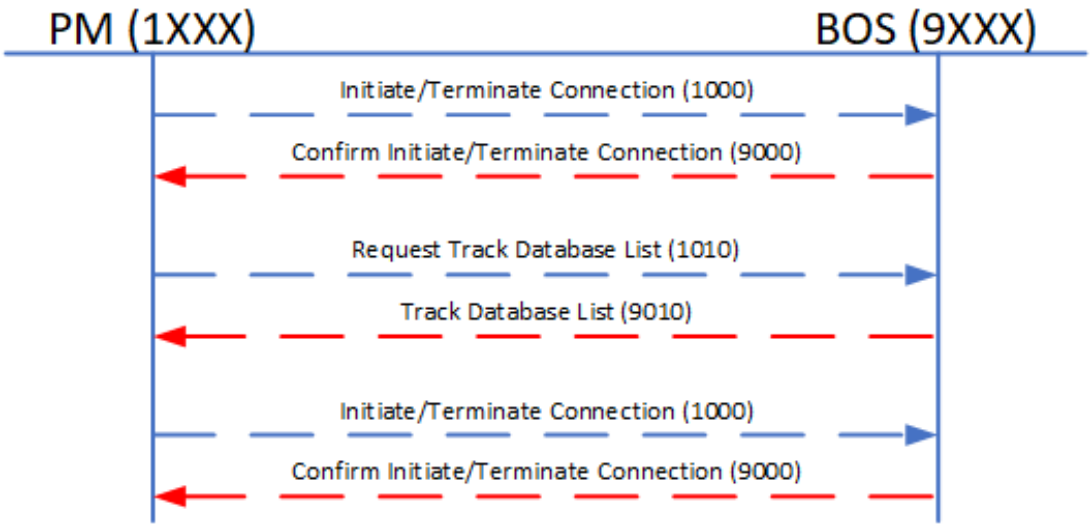

Figure H 2. Message Diagram - Track Database List

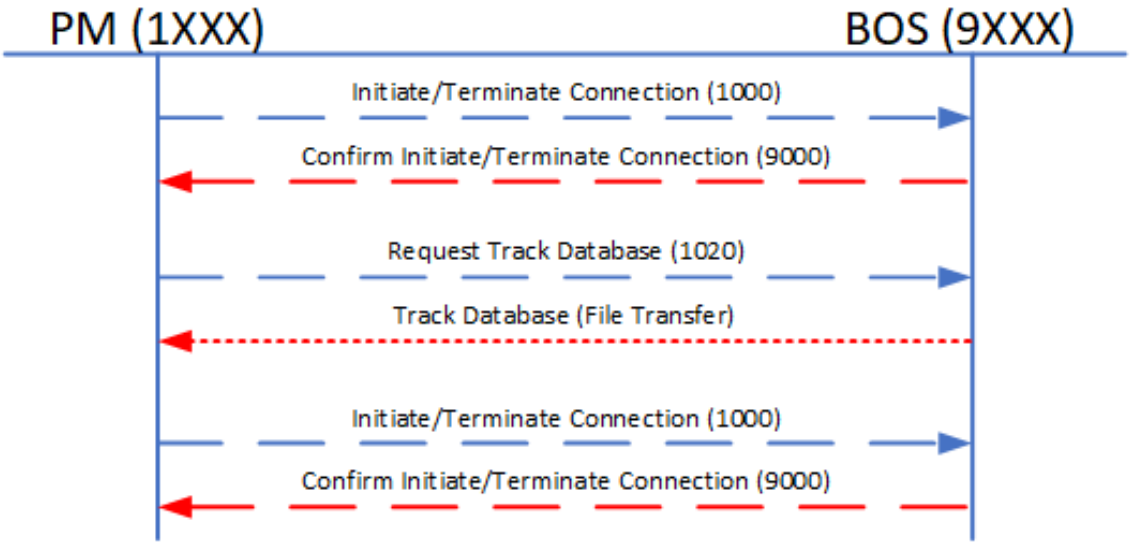

Figure H 3. Message Diagram - Track Database

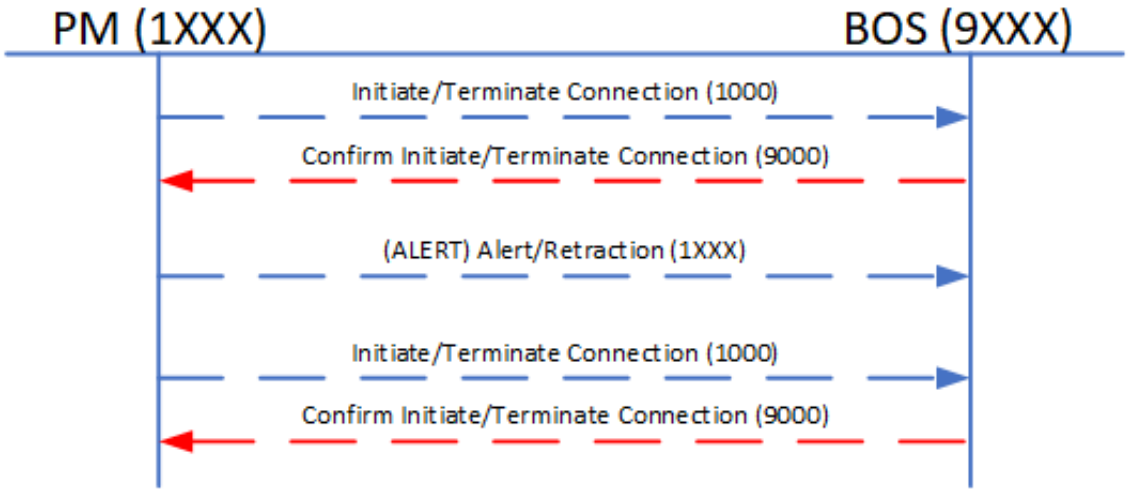

Figure H 4. Message Diagram - All Alert/Retraction Messages

2.3 Message Descriptions Between TDAS PM Subsystem and the BOS

2.3.1 Initiate/Terminate Connection (1000)

This message is sent to initiate/terminate connection between subsystems the TDAS PM subsystem and the railroad BOS. The railroad BOS authenticates the connection and responds with a Confirm Initiate/Terminate Connection message. Table H 4 details the message structure.

Table H 4. Initiate/Terminate Connection Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	1000	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	PM Software Revision	20	A	–	Subsystem software revision
5.	Date Time	7	Zb		CCYYMMDDHHMMSS
6.	Reason	1	B	ENUM	1 = Initialize connection 2 = Terminate connection
7.	Message Coordination Number	4	B		Message sequence number hashed with time for each new conversation

2.3.2 Confirm Initiate/Terminate Connection (9000)

This message is sent in response to a Initiate/Terminate Connection message. Table H 5 details the message structure.

Table H 5. Confirm Initiate/Terminate Connection Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	9000	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	PM Software Revision	20	A	–	Required software version
5.	Acceptance Status	1	B	ENUM	0 = Not used 1 = Not valid asset ID 2 = Invalid software version 3 = Other error

ID	Field	Size (Bytes)	Type	Value	Description
6.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation

2.3.3 Request Track Database List (1010)

This message is sent from the PM to the BOS to request the current track database list. The BOS responds with a Track Database List message. Table H 6 details the message structure.

Table H 6. Request Track Database List Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	1010	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation

2.3.4 Track Database List (9010)

This message is sent from the BOS to the PM in response to a Request Track Database List message. Table H 7 details the message structure.

Table H 7. Track Database List Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	4030	Message ID
2.	Message Version	1	B		Message version number
3.	DCL Asset ID	20	A		Asset tag of equipment
4.	Received Message ID	4	B	-	Message ID of message this message is acknowledging.
5.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
6.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivision				
7.	Subdivision	25	A		Subdivision Name
8.	Subdivision ID	25	A		Subdivision ID
9.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
10.	Number of Files	2	B		Number of subdivisions following
	Repeating Reference Data IDs for count in Number of Files				
11.	Reference Data ID	20	A		ID of reference data
12.	Reference Data File Name	40	A		File name and file type of reference data
	End of Repeating Reference Data IDs for count in Number of Files				
	End of Repeating Subdivision IDs for count in Number of Subdivisions				

2.3.5 Request Track Database (1020)

This message is sent from the PM to the BOS to request a track database file(s). The BOS responds by providing the requested track database files. Table H 8 details the message structure.

Table H 8. Request Track Database Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	4030	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
5.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivisions				
6.	Subdivision	25	A		Subdivision Name
7.	Subdivision ID	25	A		Subdivision ID
8.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
	End of Repeating Subdivision IDs for count in Number of Subdivisions				

2.3.6 Audit Exception Alert/Retraction (1030)

This message is sent from the PM to the BOS when an Audit Exception alert is generated or retracted. Table H 9 details the message structure.

Table H 9. Audit Exception Alert/Retraction Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	1030	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
5.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivisions				
6.	Subdivision	25	A		Subdivision Name
7.	Subdivision ID	25	A		Subdivision ID
8.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
9.	Number of Assets	2	B		Number of PTC critical assets following
	Repeating Critical Asset IDs for count in Number of Critical Assets				
11.	PTC Asset ID	4	B		Data Source ID or other
12.	Reason for Sending	1	B	ENUM	0: Not used 1: Alert 2: Retraction
13.	Reason for Retraction	1	B	ENUM	0: NA 1: Pass 2: New reference data
14.	Alert/Retraction Date	7	Zb		Date of alert or alert retraction
15.	Data Collection Date	7	Zb		Data Collection Date
	End of Repeating Critical Asset IDs for count in Number of Critical Assets				
	End of Repeating Subdivision Names for count in Number of Subdivision				

2.3.7 Insufficient Data Alert/Retraction (1040)

This message is sent from the PM to the BOS when a Reference Data Required alert is generated or retracted a PTC critical asset(s). Table H 10 details the message structure.

Table H 10. Insufficient Data Alert/Retraction Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	1040	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
5.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivisions				
6.	Subdivision	25	A		Subdivision Name
7.	Subdivision ID	25	A		Subdivision ID
8.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
	End of Repeating Subdivision Names for count in Number of Subdivisions				

2.3.8 Asset Location Close to Exceeding Limits Alert/Retraction (1050)

This message is sent from the PM to the BOS when an Asset Close to Exceeding Limits alert is generated or retracted a PTC critical asset(s). Table H 11 details the message structure.

Table H 11. Asset Location Close to Exceeding Limits Alert/Retraction Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	1050	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
5.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivisions				
6.	Subdivision	25	A		Subdivision Name
7.	Subdivision ID	25	A		Subdivision ID
8.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
9.	Number of Assets	2	B		Number of PTC critical assets following
	Repeating Critical Asset IDs for count in Number of Critical Assets				
10.	PTC Asset ID	4	B		Data Source ID or other
11.	Reason for Sending	1	B	ENUM	0: Not used 1: Alert 2: Retraction
12.	Reason for Retraction	1	B	ENUM	0: NA 1: Asset not close to exceeding limits 2: New reference data
13.	Alert/Retraction Date	7	Zb		Date of alert or alert retraction
14.	Data Collection Date	7	Zb		Data Collection Date

2.3.9 *Audit Data Refresh Notification Alert/Retraction (1060)*

This message is sent from the PM to the BOS when an Audit Data Refresh Notification Date alert is generated or retracted for a PTC critical asset(s). Table H 12 details the message structure.

Table H 12. Audit Data Refresh Notification Alert/Retraction Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	1050	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
5.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivisions				
6.	Subdivision	25	A		Subdivision Name
7.	Subdivision ID	25	A		Subdivision ID
8.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
9.	Number of Assets	2	B		Number of PTC critical assets following
	Repeating Critical Asset IDs for count in Number of Critical Assets				
10.	PTC Asset ID	4	B		Data Source ID or other
11.	Reason for Sending	1	B	ENUM	0: Not used 1: Alert 2: Retraction
12.	Reason for Retraction	1	B	ENUM	0: NA 1: Asset not close to exceeding limits 2: New reference data
13.	Alert/Retraction Date	7	Zb		Date of alert or alert retraction
14.	Data Collection Date	7	Zb		Data Collection Date

2.3.10 Audit Expired Alert/Retraction (1070)

This message is sent from the PM to the BOS when an Audit Expired alert is generated or retracted for PTC critical asset(s). Table H 13 details the message structure.

Table H 13. Audit Expired Alert/Retraction Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	1070	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
5.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivisions				
6.	Subdivision	25	A		Subdivision Name
7.	Subdivision ID	25	A		Subdivision ID
8.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
9.	Number of Assets	2	B		Number of PTC critical assets following
	Repeating Critical Asset IDs for count in Number of Critical Assets				
10.	PTC Asset ID	4	B		Data Source ID or other
11.	Reason for Sending	1	B	ENUM	0: Not used 1: Alert 2: Retraction
12.	Reason for Retraction	1	B	ENUM	0: NA 1: Audit complete 2: New reference data
13.	Alert/Retraction Date	7	Zb		Date of alert or alert retraction
14.	Audit Date	7	Zb		Last Audit Date
15.	Audit Data Collection Date	7	Zb		Audit Data Collection Date
16.	Audit Expiration Date	7	Zb		Audit Expiration Date
	End of Repeating Critical Asset IDs for count in Number of Critical Assets				
	End of Repeating Subdivision Names for count in Number of Subdivisions				

2.3.11 Reference Data Required Alert/Retraction (1080)

This message is sent from the PM to the BOS if a Reference Data Required alert is generated or retracted for a PTC critical asset(s). Table H 14 details the message structure.

Table H 14. Reference Data Required Alert/Retraction Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	1080	Message ID
2.	Message Version	1	B		Message version number
3.	PM Asset ID	20	A		Asset tag of equipment
4.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
5.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivisions				
6.	Subdivision	25	A		Subdivision Name
7.	Subdivision ID	25	A		Subdivision ID
8.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
9.	Number of Assets	2	B		Number of PTC critical assets following
	Repeating Critical Asset IDs for count in Number of Critical Assets				
10.	PTC Asset ID	4	B		Data Source ID or other
11.	Reason for Sending	1	B	ENUM	0: Not used 1: Alert 2: Retraction
12.	Alert/Retraction Date	7	Zb		Date of alert or alert retraction
13.	Data Collection Date	7	Zb		Data Collection Date
	End of Repeating Critical Asset IDs for count in Number of Critical Assets				
	End of Repeating Subdivision Names for count in Number of Subdivisions				

Appendix H.1.
Railroad Specified Interface Requirements

The message interface utilizes a TCP/IP connection with SSL for authentication and encryption. File transfers are handled via SFTP.

Appendix I.
Positive Train Control (PTC) Track Data Auditing System (TDAS): Process Management Subsystem-Data Comparison Subsystem Interface Control Document v 1.0

Process Management Subsystem-Data Comparison Subsystem Interface Control Document

1. Introduction

This document defines the message interface between the Track Data Auditing System (TDAS) Process Management (PM) subsystem and the Data Comparison subsystem. Figure I 1 depicts the TDAS architecture and highlights the interface defined within this document. The interface described includes implementation of the Data Comparison subsystem in the field, and in the railroad back office.

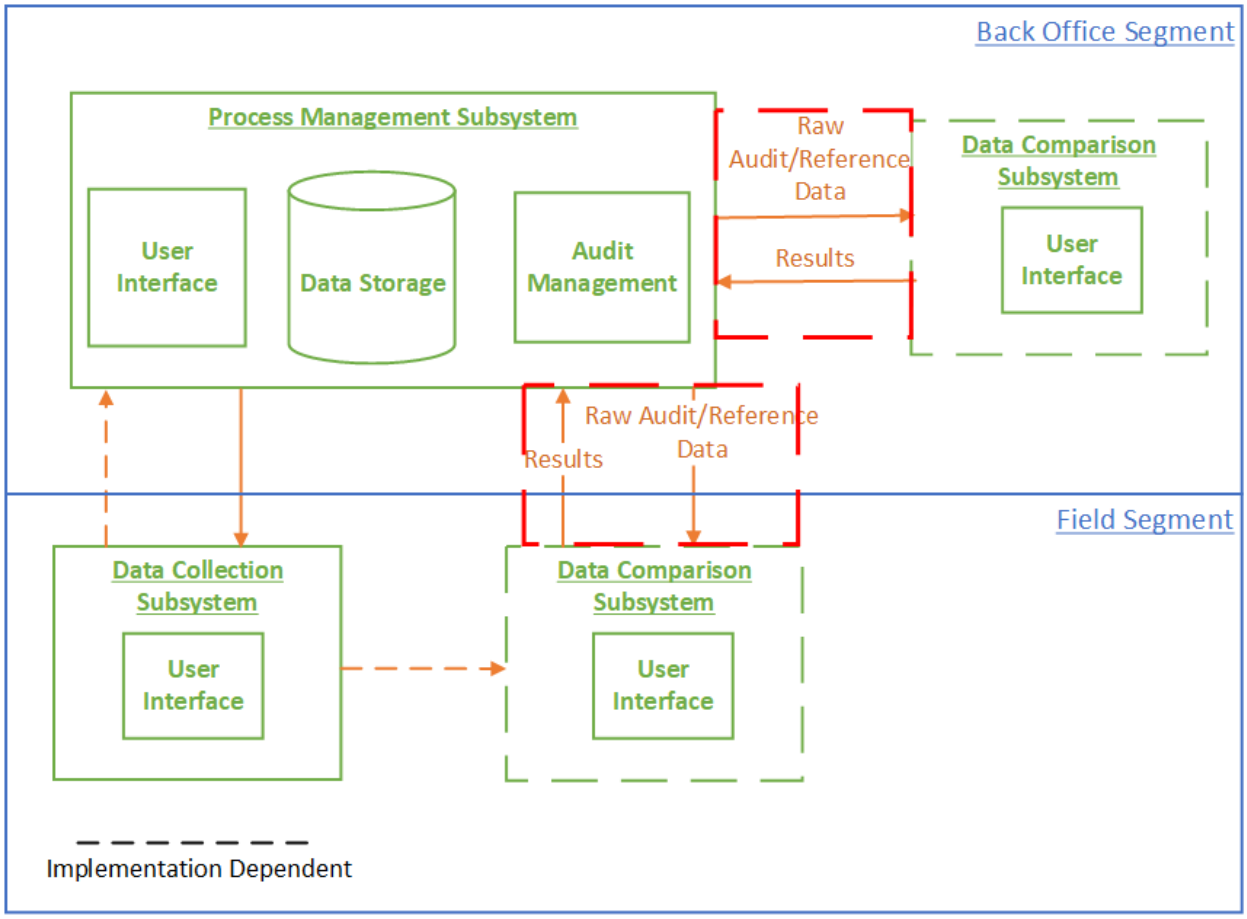

Figure I 1. PM Subsystem and Data Comparison Subsystem Interface

1.1 Applicable Documents

The following documents are applicable to the extent they are referenced in the text of this specification:

- Positive Train Control (PTC) Track Data Auditing System (TDAS) - System Requirements Specification v 2.0
- Positive Train Control (PTC) Track Data Auditing System (TDAS) - Process Management Subsystem Requirements Specification v 1.0

2. Message Details

Appendix I.1 contains additional interface requirements.

2.1 General Message Assumptions

The following do not include the header and CRC parts of the message.

- Message fields may be fixed field length or variable, as specified in this document.
- All message data types are specified in the message definition.
- All time fields are specified in UTC.
- Each message is self-contained. All data required for processing a message is contained in the message itself, not in multiple messages.
- All Character/Alpha fields are left-justified and padded with spaces if necessary.
- All Numeric fields are right-justified and prefixed with leading zeroes if needed.
- If applicable, message sizes are specified in the Size field.

The "Type" column abbreviations are shown in Table I 1:

Table I 1. "Type" Column Abbreviations

"Type" column abbreviations	Meaning
B	Binary numeric data
A	ASCII alpha or alpha/numeric data
Zb	Universal Time Coordinated (UTC)–Binary date and time field of 7 bytes in the form of CC - 1 byte, YY - 1 byte, MM DD HH MM SS – 1 byte each
Y	Yes or No field with data of either ASCII Y or ASCII N

2.2 Messages Between PM Subsystem and Data Comparison Subsystem

Table I 1 specifies the messages that are sent from the Data Comparison subsystem (DC) to the Process Management subsystem (PM) and Table I 2 specifies the messages that are sent from the PM to the DC. Figure I 2 through Figure I 4 show the sequence of messages sent between the DC and the PM for each type of data.

Table I 2. Message from DC

Message Type	Version	Description	Source	Destination
6000	1	Initiate/Terminate Connection	DC	PM
6001	1	Confirm Initiate/Terminate Connection	DC	PM
6010	1	Audit Results	DC	PM

Table I 3. Messages from PM

Message Type	Version	Description	Source	Destination
3000	1	Confirm Initiate/Terminate Connection	PM	DC
3001	1	Initiate/Terminate Connection	PM	DC

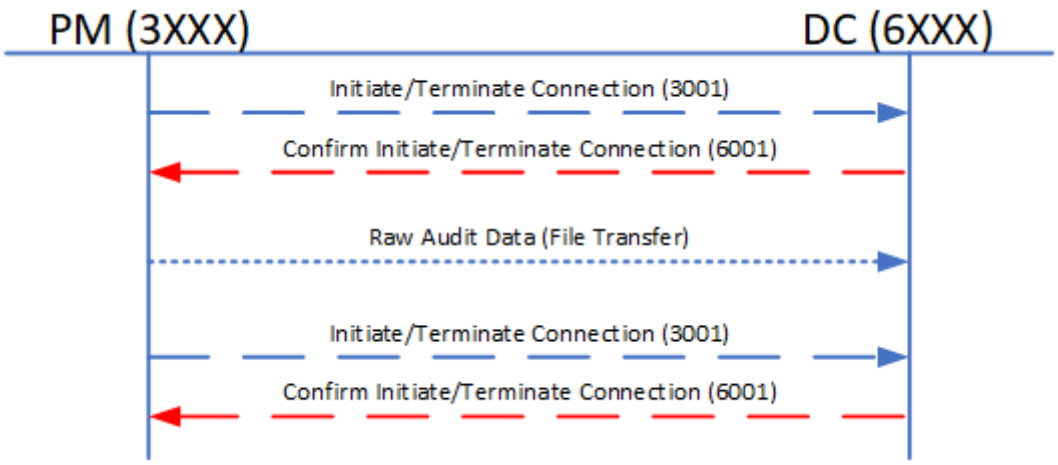

Figure I 2. Message Diagram - Raw Audit Data

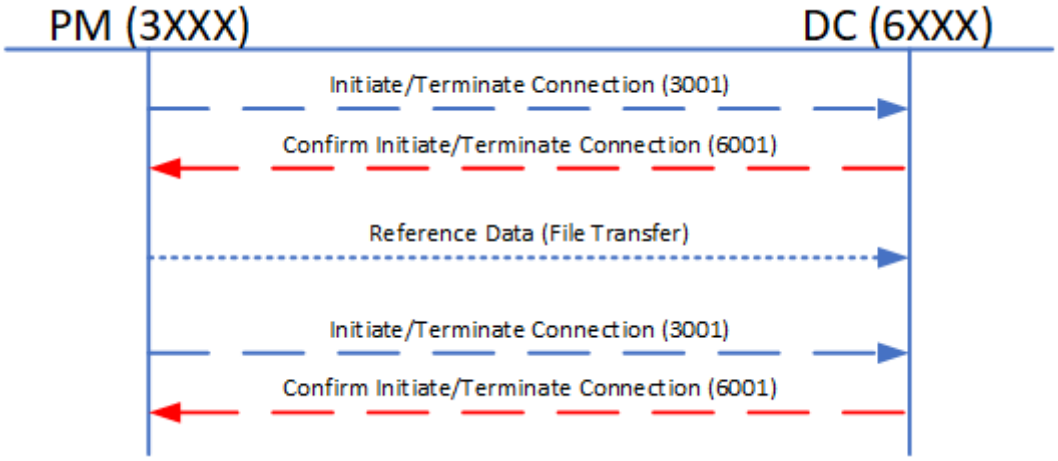

Figure I 3. Message Diagram - Reference Data

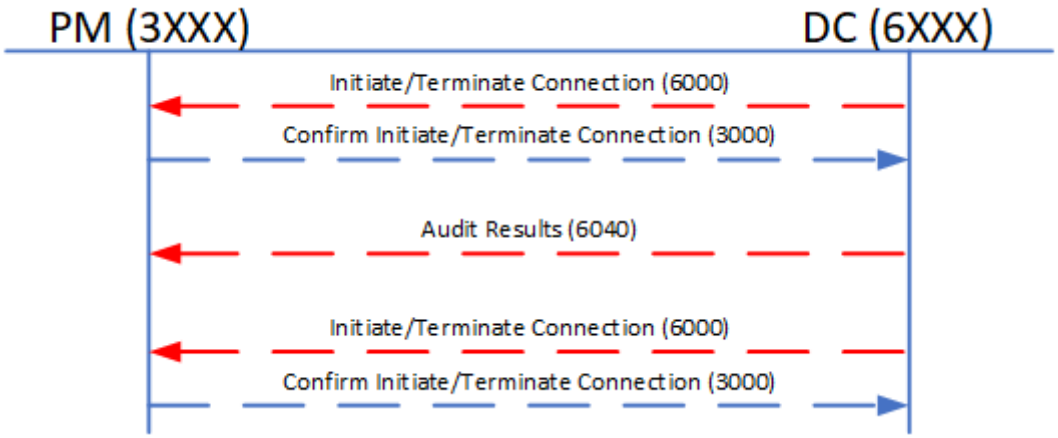

Figure I 4. Message Diagram - Audit Results

2.3 Message Descriptions Between PM Subsystem and Data Comparison Subsystem

2.3.1 Initiate/Terminate Connection (6000/3001)

This message is sent to initiate/terminate connection between subsystems. The responding subsystem authenticates the connection and responds with a Confirm Initiate/Terminate Connection message. Table I 4 details the message structure.

Table I 4. Initiate/Terminate Connection Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	-	Message ID
2.	Message Version	1	B		Message version number
3.	Asset ID	20	A		Asset tag of equipment
4.	Software Revision	20	A	–	Subsystem software revision
5.	Date Time	7	Zb		CCYYMMDDHHMMSS
6.	Reason	1	B	ENUM	1 = Initialize connection 2 = Terminate connection
7.	Message Coordination Number	4	B		Message sequence number hashed with time for each new conversation

2.3.2 Confirm Initiate/Terminate Connection (3000/6001)

This message is sent in response to an Initiate/Terminate Connection message. Table I 5 details the message structure.

Table I 5. Confirm Initiate/Terminate Connection Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	-	Message ID
2.	Message Version	1	B		Message version number
3.	Asset ID	20	A		Asset tag of equipment
4.	Software Revision	20	A	–	Required software version
5.	Acceptance Status	1	B	ENUM	0 = Not used 1 = Not valid asset ID 2 = Invalid software version 3 = Other error

ID	Field	Size (Bytes)	Type	Value	Description
6.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation

2.3.3 Audit Results (6010)

This message is sent from the DC to the PM upon completion of an audit. Table I 6 details the message structure.

Table I 6. Audit Results Message Structure

ID	Field	Size (Bytes)	Type	Value	Description
1.	Message ID	2	B	6010	Message ID
2.	Message Version	1	B		Message version number
3.	DC Asset ID	20	A		Asset tag of equipment
5.	Message Coordination Number	4	B		Message sequence number corresponding to messages in the same conversation
6.	Number of Subdivisions	2	B		Number of subdivisions following
	Repeating Subdivision Names for count in Number of Subdivisions				
7.	Subdivision	25	A		Subdivision Name
8.	Subdivision ID	25	A		Subdivision ID
9.	Subdivision File Revision Number	20	A		Subdivision File Revision Number
10.	Number of Assets	2	B		Number of PTC critical assets following
	Repeating PTC Asset IDs for count in Number of Assets				
11.	PTC Asset ID	4	B		Data Source ID or other
12.	Audit Result	1	B	ENUM	0: Not Used 1: Pass 2: Exception 3: Asset Close to Exceeding Limits 4: Insufficient data
	End of Repeating PTC Asset IDs for count in Number of Assets				
	End of Repeating Subdivision IDs for count in Number of Subdivisions				

Appendix I.1.
Railroad Specified Interface Requirements

The message interface utilizes a TCP/IP connection with SSL for authentication and encryption. File transfers are handled via SFTP.

Appendix J.
Request for Proposal for a "Positive Train Control (PTC) Track Data Auditing System (TDAS) - Data Collection Subsystem:" Cover Letter

To: Prospective Offerors

Subject: Request for Proposal for a "Positive Train Control (PTC) Track Data Auditing System (TDAS) - Data Collection Subsystem"

Transportation Technology Center, Inc. (TTCI), a wholly owned subsidiary of the Association of American Railroads (AAR), with offices located at 55500 DOT Road, Pueblo, CO, 81001, in support of a project sponsored by the Federal Railroad Administration (FRA), is seeking proposals for a Track Data Auditing System (TDAS), Data Collection subsystem, as defined in the included "Request for Proposal - Track Data Auditing System Data Collection Subsystem" that shall comply with the Functional and Non-Functional requirements as specified in that document.

The purpose of issuing this RFP is to identify a supplier or suppliers who can provide a TDAS Data Collection subsystem, as described in section 7.1 of the RFP, for the purpose of evaluating the TDAS concept through field testing at the Transportation Technology Center (TTC). Test results will be reported by TTCI, to the FRA and TDAS Technical Advisory Group (TAG) members, which includes representatives of the following organizations: BNSF Railway, Canadian Pacific Railway, Canadian National Railway Company, CSX Transportation, Kansas City Southern Railway Company, Norfolk Southern Corporation, and Union Pacific Railroad Company. Note that freight railroad operators are the ultimate end users of TDAS. Participation by TDAS suppliers in this project does not explicitly or implicitly guarantee future acquisition of TDAS products by the end users. Likewise, participation in this project does not explicitly or implicitly represent certification or acceptance of TDAS products by TTCI or FRA.

RFP Response Requirements:

The offeror shall properly execute, complete, sign and return all proposal documents by the time and date set forth below. Proposals shall be valid for a minimum period of 120 days from the due date of this RFP. Each proposal shall be in accordance with all aspects of the RFP General Procedures.

To expedite the proposal evaluation process, each offeror is required to set forth evidence that their company possesses the requisite technical expertise necessary for implementing equipment complying with the associated requirements documents. Therefore, as a minimum, each offeror shall submit as a part of the proposal package the following:

1. **RFP Understanding**. A detailed narration of how the offeror proposes to satisfy requirements of the TDAS Data Collection subsystem architecture as described in section 7.1 of the RFP.

2. **Statement of Compliance**. Offerors shall include detailed information regarding how the equipment/system offered satisfies the objectives of the railroad industry as defined in Exhibit A "PTC Critical Asset Track Data Auditing System: System Description and Operational Concept v 2.0." Offerors shall include a statement that they fully comply with all requirements in section 7.1 of the RFP, with any exceptions clearly noted.
3. **System Description**. Offerors shall include a detailed technical description of the overall system they are proposing. The description shall include discussion of all topics and requirements and quantitative details of the predicted performance for the proposed TDAS Data Collection subsystem with regard to the parameters cited in Exhibit C.
4. **Qualifications**. Offerors shall demonstrate that their firm possesses the requisite skills and capabilities to successfully complete the work specified as well as provide proof of similar experience and successful performance of similar projects.

Proposal selection, based on which supplier(s) best meet the project requirements, will be a coordinated effort by the FRA, TTCI and the TDAS TAG.

TTCI, FRA, and the TDAS TAG reserve the right to make selection of products to be tested based upon initial offers received. Therefore, the offeror's initial offer should contain the offeror's best terms considering all criteria in the Proposal/Quote Evaluation section of the RFP.

In order to be considered for evaluation and possible selection, proposals must be received no later than 3:00 P.M. MT, February 17, 2020.

Proposals shall be delivered electronically to:

Tom_Macaluso@aar.com and Adam_Anderson@aar.com

This solicitation does not commit or obligate TTCI, AAR, FRA or the TDAS TAG to pay for any cost incurred in the preparation, presentation or submission of any offer or to procure or contract for the supplies and/or services called for therein.

We look forward to your response. Should you have any questions, please contact:

For technical questions:

Adam Anderson
Senior Engineer I
TTCI
505-720-8025 – Cellular
Adam_Anderson@aar.com

For business and procurement questions:

Tom Macaluso
Senior Buyer
TTCI
(719) 584-0535 - Office
Tom_Macaluso@aar.com

Appendix K.
Request for Proposal for a "Positive Train Control (PTC) Track Data Auditing System (TDAS) - Data Collection Subsystem"

Request for Proposal

Track Data Auditing System

Data Collection Subsystem

Version 1.0

Prepared By:

Transportation Technology Center, Inc.

***A Subsidiary of the* Association of American Railroads**

55500 D.O.T. Road

P.O. Box 11130

Pueblo, Colorado, USA 81001

1. Introduction

Transportation Technology Center, Inc (TTCI), on behalf of the Federal Railroad Administration (FRA), in association with the freight railroads represented on the Track Data Auditing System (TDAS) Technical Advisory Group (TAG), has developed a Request for Proposal (RFP) for the development of the Data Collection subsystem of TDAS, and is being delivered to a limited number of external service providers (ESPs) who, it is believed, are capable and may be interested in submitting a response. While the information contained herein is believed to be accurate, TTCI expressly disclaims any and all liability for representations, expressed or implied, contained in, or for omissions from, this RFP or any other written or oral communication transmitted to any interested party in the course of its evaluation. Only those particular representations and warranties, which may be made by TTCI in a definitive written agreement, when and if one is executed, and subject to such limitations and restrictions, as may be specified in such agreement, shall have any legal effect. This RFP also may include certain statements, estimates and projections provided by TTCI reflecting significant assumptions and subjective judgments by agents of TTCI concerning anticipated growth. These assumptions and judgments may or may not prove to be correct and there can be no assurance that any projected results will be realized. Except where otherwise indicated, this RFP speaks as of the date hereof.

1.1 Background and Scope

The following is an RFP for a TDAS Data Collection subsystem. The Data Collection subsystem is one of three subsystems comprising TDAS as described in Exhibit A, “PTC Critical Asset Track Data Auditing System: System Description and Operational Concept v 2.0.”

FRA has funded a program to develop a track data auditing system. The scope of work for this phase of the program includes tasks procure a prototype Data Collection subsystem, and to test and evaluate the subsystem. One objective of this phase of the program is to verify that the prototype meets the requirements established in prior phases, through field and laboratory testing.

Field testing will cover a variety of operational conditions and utilize Positive Train Control (PTC) critical assets currently in place at TTCI. Laboratory testing of the data collection segment prototype interfaces will be conducted to verify that communication requirements specified in the ICDs (i.e., “Positive Train Control [PTC]Track Data Auditing System (TDAS) - Process Management Subsystem - Data Collection Subsystem Interface Control Document,” (Exhibit D) and “Positive Train Control (PTC) Track Data Auditing System (TDAS) - Data Collection Subsystem - Data Comparison Subsystem Interface Control Document” [Exhibit E]) are met.

1.2 Applicable Documents

The following documents apply to the extent they are referenced in the text of this specification:

- Exhibit A, “PTC Critical Asset Track Data Auditing System: System Description and Operational Concept v 2.0”
- Exhibit B, “Positive Train Control (PTC) Track Data Auditing System (TDAS) - System Requirements Specification v 2.0”

- Exhibit C, “Positive Train Control (PTC) Track Data Auditing System (TDAS) - Data Collection Subsystem Requirements Specification v 1.0”
- Exhibit D, “Positive Train Control (PTC) Track Data Auditing System (TDAS) – Data Collection Subsystem - Process Management Subsystem Interface Control Document v 1.0”
- Exhibit E, “Positive Train Control (PTC) Track Data Auditing System (TDAS) – Data Collection Subsystem - Data Comparison Subsystem Interface Control Document v 1.0”

2. General Procedures

To ensure a fair analysis of all RFP responses, suppliers must comply with the provisions set out in this section. Supplier queries and contacts associated with the RFP will be handled directly by the point of contact listed below.

2.1 Points of Contacts

All proposals and questions should be submitted to:

For technical questions:

Adam Anderson
Senior Engineer I
TTCI
505-720-8025 – Cellular
Adam_Anderson@aar.com

For business and procurement questions:

Tom Macaluso
Senior Buyer
TTCI
(719) 584-0535 - Office
Tom_Macaluso@aar.com

2.2 Schedule of Events

Table K 1. Schedule of Events

RFP Released	February 4, 2020
Supplier Questions Due	February 10, 2020
TTCI Response to Questions Due	February 12, 2020
Supplier Responses Due (including financial quote)	February 17, 2020
Supplier(s) Selection	February 21, 2020

Table K 2.Testing of Data Collection Subsystem Prototype(s)

Laboratory Testing	April 2020
Field Testing	May 2020

* TTCI reserves the right to change the schedule if necessary.

2.3 Response Format and Requirements

Authority
All proposals must be signed (i.e., electronic signature is accepted) by an officer or employee having authority to commit the supplier to the proposal. Proposals submitted must remain valid for a minimum of 120 days.

Executive Summary
Include an executive summary of your company, including recent annual reports of comparable financial statements.

Acknowledgment of RFP Receipt
Within two business days of your receipt of this RFP, please email acknowledgment to Tom Macaluso with your intent to participate.

Election to Not Submit a Response to the RFP
In the event you elect not to submit a response to the RFP, please notify by email Tom Macaluso.

RFP Questions and Clarifications
Questions must be submitted in writing by email.

Proposal Submittal Guidelines
For your proposal to receive consideration, a copy of your proposal, inclusive of all supporting documents, should be sent via email to Tom Macaluso, electronically by 3:00 pm MT on February 17, 2020.

TTCI will acknowledge receipt of all proposals submitted prior to the above deadline. Proposals received after the deadline or not in compliance with these instructions may not be considered.

Modification of RFP
After the TTCI analysis of proposals submitted in response to this RFP, TTCI reserves the right to modify the requirements and terms of this RFP. TTCI may also request resubmission of some or all items from some or all of the initial suppliers.

3. Standard Terms and Conditions

Disclosure and Confidentiality Terms
The information contained in this RFP (or accumulated through other written or verbal communication) is confidential. It is for RFP purposes only and is not to be disclosed or used for any other purpose. Information received in response to this RFP will be held in strict confidence and will not be disclosed to any party, other than TTCI, FRA, and the TDAS TAG without the express written consent of supplier.

Conflict of Interest
All suppliers must disclose the name of any officer, director, or agent who is also an employee of any AAR member railroad company. All suppliers must disclose the name of any AAR employee who owns, directly or indirectly, any interest in the supplier's business or any of its branches.

AAR Remuneration Policy
It is TTCI and AAR policy that TTCI and AAR employees not accept royalties, commissions, or any form of third-party remuneration from any supplier or associated supplier organizations for the purposes of securing an agreement award. Such offers from suppliers will immediately disqualify them from the RFP solicitation process.

Lobbying
During the RFP period, there will be no contact between the supplier and anyone within TTCI and AAR or the affiliated railroads concerning this RFP, with the exception of the Proposal designates listed within the RFP document under Points of Contact, Tom Macaluso. All supplier-initiated contact relating to this RFP should be made through email and, for critical urgent items only, by phone. TTCI will disqualify any supplier who unilaterally attempts to initiate contact with any TTCI or AAR or its affiliated member railroads on this matter.

Dedicated Account Manager
A dedicated account manager(s) to service TTCI services needs will be required by the supplier receiving the contract award.

Quality Assurance
TTCI requires that critical suppliers and service providers have a quality assurance program in place. Please indicate whether your facility/company has a quality program.

Proposal/Quote Evaluation
The supplier quotes will be evaluated by TTCI, FRA, and the TDAS TAG based on a number of criteria including, but not necessarily limited to nor weighted in the order of the following:

- Ability to meet or exceed specified requirements
- Prior experience of the supplier in successfully providing services and/or products similar in scope, technology, or application
- The completeness of the quote with respect to the information requested in the RFP
- Flexibility in product functionality to allow for differences in future direction with regard to how the processes function around the context of the products proposed
- Projected total cost for the duration of the agreement

- Enhanced features or services, including functionality or services that distinguish one solution over the others
- Degree and ease of integration of proposed solutions with existing infrastructure and processes

TTCI, FRA, and the TAG reserve the right to interview all responding suppliers and may require a formal presentation with the key people who will administer and be assigned to work on the Project before recommendation of award.

The final decision regarding supplier selection and contract award will be subject to TTCI and legal review and approval.

Any suppliers receiving and/or otherwise acquiring this RFP acknowledge and agree that, TTCI and FRA will exercise their discretion in the review and decision process. Each supplier submitting a response does so recognizing that no cause or action or claim will arise in such supplier's favor against TTCI, FRA, or any person, firm, corporation, or legal entity associated with these entities as a result of the exercise of their discretion. TTCI, FRA and any of their affiliates and subsidiaries, will in no way, be liable for any direct or indirect damages incurred as part of the RFP process, decision, and award or procurement process.

TTCI and FRA reserve the right to reject, in whole or in part, any and all proposal submissions and award an agreement or agreement as it sees fit. TTCI and FRA may choose to award separate agreements for various functional components, or to a sole supplier based on the satisfaction of the interest being evaluated. By submitting the proposals, responding suppliers hereby waive all rights to appeal or contest such an award under any circumstances.

The RFP response and any supporting reference documentation submitted by the selected supplier may be included in the final agreement between TTCI, FRA, and the supplier.

Agreement Structure

Any agreement between TTCI, FRA, and the successful supplier/service provider is contingent upon the award of the RFP. However, TTCI has certain clauses, which it requires in its agreements, which suppliers should give consideration to when submitting their proposal. These clauses include, but are not limited to:

- TTCI reserves to itself the right to terminate the agreement for convenience on written notice to supplier.
- Indemnification for damages resulting from supplier/provider's actions or omissions as well as indemnification for claims against TTCI and FRA by third parties for IP infringement.
- Commercial general liability insurance with a minimum policy limits set at one million dollars, along with coverage for workers compensation, business automobile and errors and omissions liability coverage.
- Approval of supplier/service provider's employees that are assigned to provide services to TTCI.
- Any dispute arising out of or under this RFP, or any resulting Agreement shall be resolved by binding arbitration conducted in Denver, CO, shipments are Freight on Board (FOB) Destination.

- Shipments shall be FOB Destination
- Confidentiality, data privacy and information security

Acceptance Testing and Proof of Performance
TTCI and the supplier shall establish specifications that shall become part of the agreement, which shall be based upon, but not necessarily limited to, the relevant sections of the RFP and the supplier's Proposal. All deliverables shall conform to such specifications. After the supplier submits a deliverable to TTCI, there shall be a period during which TTCI reviews the deliverable to determine if it meets the specifications established in the agreement. If it does not meet the specifications, supplier will have a period of time in which to make the deliverable conform to the specifications. TTCI will require a satisfactory proof of performance and resolution of all major issues at each stage of the Project before work proceeds on subsequent stages. TTCI shall consider failure to meet the specifications within that period to be a material breach.

Payment Terms
Payment Terms will be Net 30 days from receipt of supplier invoice. All invoices must be submitted to accounts_payable@aar.com

Disclaimers

Supplier is hereby advised that TTCI is not committed to any course of action as a result of its issuance of this RFP and/or its receipt of a Proposal/Quote from any supplier in response to it. Further, TTCI reserves the right to:

- Reject any Proposal/Quote which does not conform to instructions and specifications which are issued herein
- Not accept Proposal/Quotes after the stated submission deadline
- Reject any or all Proposal/Quotes, if it so decides
- Negotiate with one or more suppliers
- Award a contract in connection with this RFP at any time
- Award only a portion of the contract
- Make no award of any contracts

TTCI explicitly reserves the right to contract with a supplier for reasons other than the lowest price. TTCI will not reimburse any supplier for any preparation costs or other work performed in connection with this RFP.

Preparation Costs
Costs incurred by the service providers in preparation of proposals in response to this RFP, shall be borne by said service providers. The rejection of any Proposal, in whole or in part, will not render TTCI liable for such costs or damages arising from Proposal preparation.

Diversity
TTCI encourages the use of small businesses, including women, veteran, and minority-owned small businesses in the provision of goods and services. TTCI is committed to a procurement process that provides opportunities for all suppliers, regardless of any social or economic distinction, such as age, race, creed, color, sex, ancestry or national origin.

Regulations
The system must be compliant with all applicable local, State and Federal regulations.

4. Prototype Evaluation

The prototype Data Collection subsystem procured through this RFP will be used to evaluate the feasibility of a Data Collection subsystem as described throughout this document, in Exhibit A, and "Positive Train Control (PTC) Track Data Auditing System (TDAS) - System Requirements Specification v 2.0" (Exhibit B). This phase of the TDAS program is intended to demonstrate a Data Collection subsystem that meets the minimum requirements as described in Section 4.1 of this document. Although, it will not be possible to test a complete implementation of TDAS, including the other subsystems described in Exhibits A and B, all requirements associated with the Data Collection subsystem will be verified through simulated interface and field testing.

4.1 Requirements

The Data Collection subsystem shall comply with the Functional and Non-Functional requirements as specified in "Positive Train Control (PTC) Track Data Auditing System (TDAS) - Data Collection Subsystem Requirements Specification v 1.0" (Exhibit C), as well as the interface requirements specified in Exhibits D and E. Vendors will indicate which requirements cannot be met along with any notes or questions.

4.2 Laboratory Testing

TTCI will develop a test matrix for the evaluation of the Data Collection subsystem

prototype interface. TTCI will develop test software to interface with the Data Collection subsystem prototype, with technical support from the vendor, and perform tests to verify communication requirements outlined in the ICD are met.

4.3 Field Testing

TTCI will develop a field test matrix for the testing that will be conducted at the Transportation Technology Center (TTC). This will include a variety of environmental

conditions and PTC critical asset types currently in place at the TTC and selected with input from the AG. TTCI will perform field testing of the Data Collection subsystem prototype and analyze data produced by the field tests to verify all requirements are met. The results of this analysis will be reviewed with the vendor(s). TTCI will determine recommendations, should the prototype(s) be unable to meet the established requirements.

4.4 Price Quotes

Price quotes are to be prepared showing the associated costs for the prototype subsystem, as well as estimated unit costs should the subsystem be productized. It is also requested that vendors provide a quote for any technical support that may be needed during the evaluation of the subsystem prototype. Proposals will be rejected if this information is not provided.

In addition to a price quote for a Data Collection subsystem capable of meeting the minimum accuracy specified in Exhibit C, requirement SS_DCL 6.1-8, vendors are encouraged to provide cost estimates for higher-accuracy implementations.

Appendix K.1.
Data Privacy Provisions

1. **SSAE-16 Audit**: If available, PROVIDER agrees to grant access to TTCI to review results from a SSAE-16 audit expressing an opinion on the fairness of the presentation of the controls, the design of the controls in terms of their ability to meet defined control objectives, and the operational effectiveness of those controls over a defined period. If available, TTCI reserves the right to: 1) review the opinion page to see if the opinion was unqualified (i.e., no material issues found), or qualified (i.e., material issues found by the auditors), 2) review the controls tested to see if they cover TTCI minimum standards, and 3) review the controls tested to determine if there were any audit exceptions.
2. **Compliance with Information Privacy/Security Laws**: Notwithstanding anything to the contrary in this Agreement, PROVIDER agrees to comply with all applicable laws and regulations relating to the privacy or security of TTCI information. At all times, PROVIDER shall comply with any applicable laws or regulations related to advertising or marketing, including but not limited to the CAN-SPAM Act of 2003, the Telephone Consumer Protection Act and the Telemarketing Sales Rule.
3. **Third Party Disclosure**: PROVIDER agrees that it will not collect, use or disclose to any third-party, TTCI, AAR or member railroad information for any purpose other than to perform services in accordance with this Agreement in accordance with applicable law.
4. **Security Controls**: PROVIDER shall maintain and upon request of TTCI, provide documentation of the controls for the physical and logical security of the hosted applications infrastructure and the maintenance and currency of those controls. In this context, applications infrastructure refers to servers, network equipment, operating systems, applications, and any technologies not specified that are critical to the secure operation of the PROVIDER hosted functionality for which AAR has contracted.
5. **Provider User Access Privileges**: PROVIDER, upon request of TTCI, shall provide documentation detailing those users or groups from PROVIDER that will have access to TTCI data, including documentation of the process for obtaining that access and password controls.
6. **Incident Response Plan; Data Breach**: PROVIDER shall maintain and provide upon request a documented Incident Response Plan, clearly illustrating the steps it takes when a security incident occurs. In the event PROVIDER becomes aware of any unauthorized access to or disclosure or use of TTCI data (in each case, a "Breach"), it shall immediately notify TTCI of the Breach and undertake and report the results of whatever investigation of the circumstances of such Breach as TTCI reasonably may request. PROVIDER agrees to undertake whatever measures TTCI reasonably may require to protect or to minimize harm to TTCI arising from a Breach, including but not limited to agreeing to bear the cost of any notice to TTCI employees required by applicable law, regulation or that TTCI believes is otherwise advisable and any damages to TTCI arising from the Breach.

7. **Business Continuity Plan**: PROVIDER will maintain, and provide upon request, a documented Business Continuity Plan. Unless otherwise specified, the plan will support restoration of TTCI service for PROVIDER-impacting incidents within 48 hours of the incident.
8. **Encryption; No Commingling**: PROVIDER will encrypt any confidential TTCI data. Unless otherwise stipulated, data at rest will be segregated from other entity's data and encrypted. Unless otherwise stipulated, support to encrypt data in transit will be provided by PROVIDER for transmission to TTCI.
9. **Quality Assurance Testing**: If PROVIDER provides a custom-built application, upon request, PROVIDER shall provide documentation of PROVIDER security Quality Assurance testing process for the application.
10. **Troubleshooting; System Performance**: It shall be the responsibility of PROVIDER to troubleshoot problems related to system performance on PROVIDER infrastructure. PROVIDER agrees to satisfy requests from TTCI for assistance troubleshooting and resolving issues related to overall system performance, responsiveness or functionality. Upon request, TTCI is entitled to data indicating system responsiveness and performance/capacity data on supporting infrastructure.
11. **Return/Destruction of AAR Information**: All TTCI Information shall be destroyed or returned to TTCI after its intended use. Any custom tools or data access methods required by TTCI to use the information shall be provided along with any data returned. PROVIDER will provide written notification that TTCI data has been destroyed.
12. **System Capacity Service Level**: PROVIDER agrees to maintain sufficient system capacity to be able to support the expected TTCI peak concurrent user loads without significantly impacting system performance. PROVIDER agrees to monitor capacity and provide capacity measurements upon request of TTCI. A variation in performance characteristics of more than 20 percent is considered significant in this context.
13. **System Changes**: PROVIDER will notify TTCI of system changes that could impact TTCI users in advance of any changes. All changes shall be tested prior to implementation.
14. **System Availability Service Level**: Unless otherwise specified and apart from planned outages, PROVIDER is required to maintain system availability at a level of 99.8 percent available for use by TTCI. Upon request, PROVIDER will provide data on system availability. Any planned outages must be negotiated between PROVIDER and TTCI prior to the time of the planned outage.
15. **Maintenance System Functionality**: If the system functionality does not meet requirements stipulated in the Agreement, as determined by TTCI, PROVIDER will resolve any issues specified by TTCI. TTCI will notify PROVIDER in writing of any such issues involving system functionality. A response to the notification will be provided by PROVIDER within 5 business days. Unless both parties agree to a different timeline, functionality concerns will be resolved within 30 days.
16. **Record Retention; Legal Hold - Discovery**: PROVIDER agrees to manage TTCI information in alignment with TTCI Records Retention Schedule and other Information Management policies stipulated in the Agreement. Unless otherwise specified,

PROVIDER will respond to requests for Legal Holds that may apply to the TTCI information and maintain TTCI information in accordance with the stipulations of the legal holds. TTCI shall have the right to copy records and to have removed copies of records from PROVIDER's place of business.

17. **Audit**: TTCI retains the right, at its sole discretion and upon reasonable notice to review and audit PROVIDER's practices regarding the confidentiality and security of TTCI Information. Such review or audit shall include inspection of PROVIDER's records which relate to its compliance with applicable Agreements between TTCI and PROVIDER. TTCI, at its sole election, may also retain a third party to conduct the inspection or audit on its behalf or to assist in such inspection or audit. Such third party may not be a competitor of PROVIDER, absent PROVIDER's written consent. During the inspection or audit, TTCI shall have the right to copy records and to have removed copies of records from PROVIDER's place of business.

Appendix L.
Request for Proposal for a "Positive Train Control (PTC) Track Data Auditing System (TDAS) - Process Management Subsystem": Cover Letter

To: Prospective Offerors

Subject: Request for Proposal for a "Positive Train Control (PTC) Track Data Auditing System (TDAS) – Process Management Subsystem"

Transportation Technology Center, Inc. (TTCI), a wholly owned subsidiary of the Association of American Railroads (AAR), with offices located at 55500 DOT Road, Pueblo, CO, 81001, in support of a project sponsored by the FRA, is seeking proposals for a TDAS, Process Management subsystem, as defined in the included appendices, that shall comply with the Functional and Non-Functional requirements as specified in appendices C through E.

The purpose of issuing this RFP is to identify a supplier or suppliers who can provide a TDAS Process Management subsystem, as described in the included appendices. Note that freight railroad operators are the ultimate end users of TDAS. Participation by TDAS suppliers in this project does not explicitly or implicitly guarantee future acquisition of TDAS products by the end users. Likewise, participation in this project does not explicitly or implicitly represent certification or acceptance of TDAS products by TTCI or FRA.

RFP Response Requirements:

Proposals shall be valid for a minimum period of 120 days from the due date of this RFP. Each proposal shall be in accordance with all aspects of the RFP General Procedures.

To expedite the proposal evaluation process, each offeror is required to set forth evidence that their company possesses the requisite technical expertise necessary for implementing equipment complying with the associated requirements documents. Therefore, as a minimum, each offeror shall submit as a part of the proposal package the following:

1. RFP Understanding. A detailed narration of how the offeror proposes to satisfy requirements of the TDAS Process Management subsystem architecture as described in the included appendix documents.
2. Statement of Compliance. Offerors shall include detailed information regarding how the equipment/system offered satisfies the objectives of the railroad industry as defined in Appendix A. Offerors shall include a statement that they fully comply with all requirements in appendices C through E, with any exceptions clearly noted.
3. System Description. Offerors shall include a detailed technical description of the overall system they are proposing. The description shall include discussion of all topics and requirements and quantitative details of the predicted performance for the proposed

TDAS Process Management subsystem with regard to the parameters cited in Appendix C.

4. Qualifications. Offerors shall demonstrate that their firm possesses the requisite skills and capabilities to successfully complete the work specified as well as provide proof of similar experience and successful performance of similar projects.

Proposal selection, based on which supplier(s) best meet the project requirements, will be a coordinated effort by the FRA, TTCI and the TDAS TAG.

TTCI, FRA, and the TDAS TAG reserve the right to make selection of products to be tested based upon initial offers received. Therefore, the offeror's initial offer should contain the offeror's best terms considering all criteria in the Proposal/Quote Evaluation section of the RFP.

Proposals shall be delivered electronically to:

Tom_Macaluso@aar.com and Adam_Anderson@aar.com

This solicitation does not commit or obligate TTCI, AAR, FRA or the TDAS TAG to pay for any cost incurred in the preparation, presentation or submission of any offer or to procure or contract for the supplies and/or services called for therein.

We look forward to your response. Should you have any questions, please contact:

For technical questions:

Adam Anderson
Senior Engineer I
TTCI
505-720-8025 – Cellular
Adam_Anderson@aar.com

For business and procurement questions:

Tom Macaluso
Senior Buyer
TTCI
(719) 584-0535 - Office
Tom_Macaluso@aar.com

Appendix M.
DCL_RFP Trade Table

Table M 1. DCL_RFP Trade Table

Evaluation Metric	Associated DCL SS Requirement/ICDs		Weight	Vendor 1 COTS	Multiplier	Score	Vendor 1 Prototype	Multiplier	Score	Vendor 2 Prototype	Multiplier	Score	Vendor 3 COTS	Multiplier	Score	Vendor 3 COTS (High Accuracy)	Multiplier	Score	Vendor 4 COTS	Multiplier	Score
Functional Requirements		Technology		LiDAR+Panoramic Camera			LiDAR+Panoramic Camera			4 Camera System			2 LiDAR System			3 LiDAR System			Camera		
	6.1	Machine Vision Sensors Mount to Suggested Platform(s)	5	Yes (Hirail w/external power)	0.5	2.5	Yes (hi-rail w/external power)	0.5	2.5	Yes (Locomotive, hi-rail, rail car)	1	5	Yes (hi-rail, locomotive)	1	5	Yes (locomotive)	0.5	2.5	Yes (hirail, locomotive)	1	5
	6.1-3 - 6.1-6	Collects Required Data	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5
	6.2-1 - 6.2-9 / PM-DCL ICD, DC-DCL	Adheres to All ICD Message Requirements	4	No	0	0	Yes	1	4	Yes	1	4	Yes	1	4	Yes	1	4	No	0	0
	6.1-1, 6.2-10, 6.2.1-1, 6.3-1 - 6.3-3	Supports Automated Data Collection	5	No	0	0	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5
	6.1-2	Supports Manual Data Collection	3	Yes	1	3	Yes	1	3	Yes	1	3	Yes	1	3	Yes	1	3	Yes	1	3
	6.2.1-2 - 6.2.1-4	Meets All Reference Data Requirements	5	No	0.5	2.5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5	No	0	0
	6.4-1	Supports User Configuration	4	No	0	0	Yes	1	4	Yes	1	4	Yes	1	4	Yes	1	4	No	0	0
Performance Requirements	6.1-7 - 6.1-8	Meets Accuracy Requirements	5	Yes (≤ 1 ft)	1.7	8.5	Yes (≤ 1 ft)	1.7	8.5	Yes (≤ 3.5 ft)	1	5	Yes (NE)	1	5	Yes (NE)	1	5	Yes	1	5
	6.1-9	Meets Data Quality Requirements at ≤ 79 mph	5	No (≤ 40 mph)	0.5	2.5	No (≤ 40 mph)	0.5	2.5	Yes (≤ 90 mph)	1.1	5.5	Yes	1	5	Yes	1	5	Yes	1	5
	6.1-10	Capable of Capturing Data in One Pass	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5
	6.1-11	Meets Data Quality Requirements at 50 ft Above Rail	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5
	6.1-12	Meets Data Quality Requirements at 50 ft Lateral to Rail	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5	Yes	1	5
Cost		Single-Unit Cost	2	$75,000 (Lease)	0.5	1	$400,000	0.2	0.4	$295,000	0.3	0.6	$262,361	0.3	0.6	$389,180	0.2	0.4	$287,526 (Lease)	0.2	0.4
		Support Cost	1	$61,000	0.2	0.2	$61,000	0.2	0.2	DNP	0	0	$14,987	1	1	$14,987	1	1	IIP	1	1
		Production Unit Cost		DNP			DNP			$38,000 (0-100) $34,000 (101-1000)			DNP			DNP			DNP		
			59			40.2			55.1			57.1			57.6			54.9			44.4

Legend	
DNP	Did Not Provide
NE	No Estimate
IIP	Included in Price

Abbreviations and Acronyms

ACRONYM	EXPLANATION
AG	Advisory Group
ASCII	American Standard Code for Information Interchange
AAR	Association of American Railroads
BOS	Back Office Server
CTC	Centralized Traffic Control
ConOps	Concept of Operations
DCL	Data Collection
DC	Data Comparison
ESPs	External Service Providers
FRA	Federal Railroad Administration
FOB	Freight on Board
GIS	Geographic Information Systems
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HMI	Human-Machine Interface
ICD	Interface Control Document
I-ETMS	Interoperable Electronic Train Management System
ITC	Interoperable Train Control
LiDAR	Light Detection and Ranging
MSRP	Manual of Standard Recommended Practices
PTC	Positive Train Control
PM	Process Management
RSIA ‘08	Rail Safety Improvement Act of 2008
RFP	Request for Proposal
TAG	Technical Advisory Group
TDAS	Track Data Auditing System
TWC	Track Warrant Control
TTC	Transportation Technology Center
TTCI	Transportation Technology Center, Inc.
UAS	Unmanned Aerial System
UTC	Universal Time Coordinated