Managing Traffic Management System (TMS) Assets

Transportation Management Center (TMC) Pooled-Fund Study (PFS)
Federal Highway Administration (FHWA)
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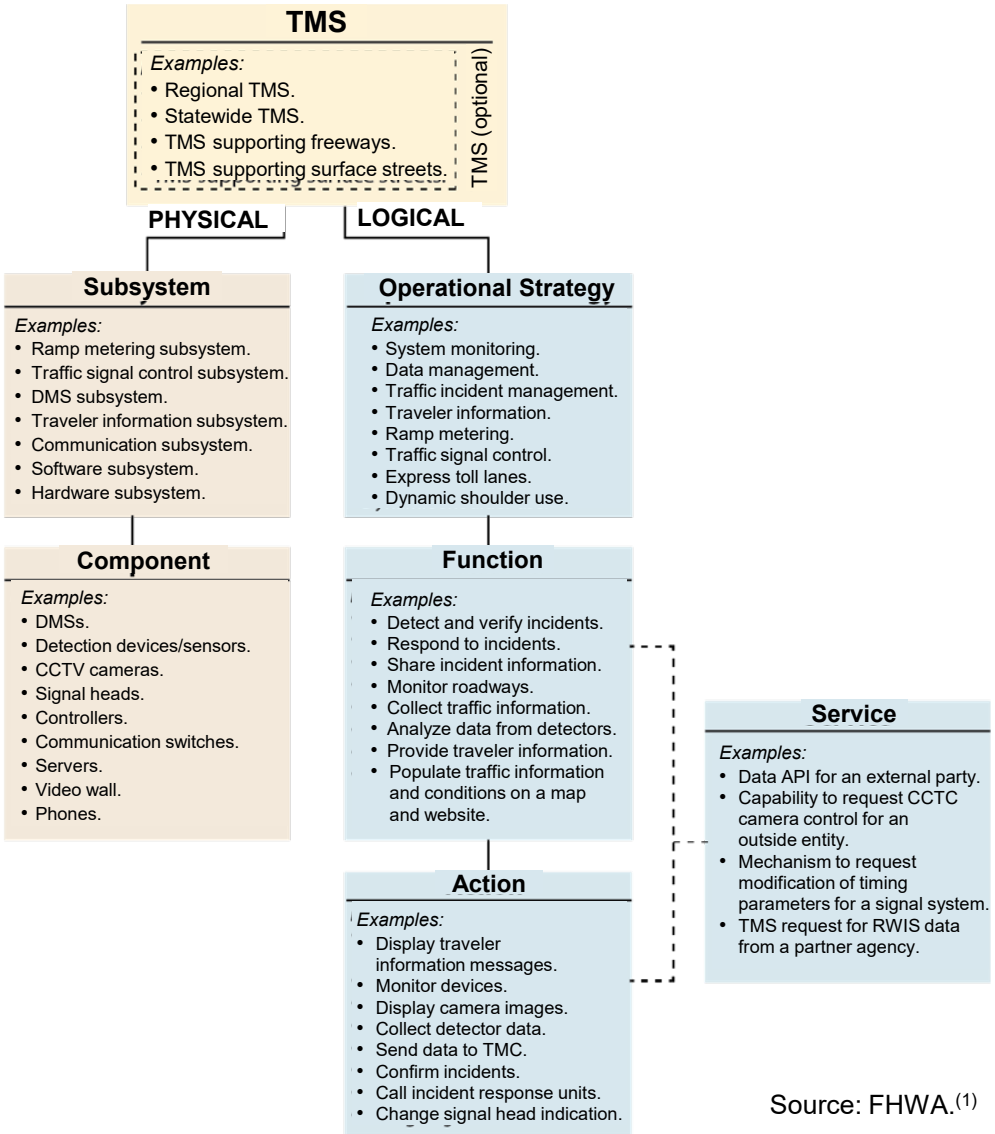
U.S. Department of Transportation
Federal Highway Administration

Managing TMS Assets

Introduction to Managing TMS Assets

What Are TMSs?

- Complex operational systems that combine field equipment, advanced communications and information technology, and software.
- Software that collects and synthesizes traffic data, integrates external systems, and enables command and control of intelligent transportation system (ITS) field devices.
- TMS assets that are typically technology-based and must be managed differently than infrastructure assets.



Source: FHWA.[1]

API = application programming interface; DMS = dynamic messages sign; RWIS = Roadway Weather Information System.

TMS Asset Characteristics

TMS assets are unique from traditional transportation assets, such as pavements and bridges, because of their complexity and because they are based on technologies. Characteristics of TMS assets include:

- Technological elements.
- Monitoring.
- Failure mode.
- Functional obsolescence.
- Fungibility.
- Portability.
- Communications.

Transportation Asset Management (TAM)

23 Code of Federal Regulations (CFR) § 515.5 defines TAM as:[2]

> *A strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the life cycle of the assets at minimum practicable cost.*

How Does Managing Assets Differ From Asset Management?

Managing assets focuses on:

- Caring for assets to support availability, reliability, and dependability.
- Managing data that defines the assets, such as make and model, locations, quantities, and conditions.
- Understanding needs and conducting maintenance and repairs.
- Monitoring and measuring asset performance.
- Identifying resources and tools to support managing the assets.

Asset management focuses on:

- Identifying how assets address agency objectives.
- Predicting and planning for long-term outcomes.
- Measuring how assets contribute to agency value.

What Are the Connections Between Transportation System Management and Operations (TSMO) and Managing TMS Assets?

Potential connections within a TSMO program and the management of TMS assets may include:

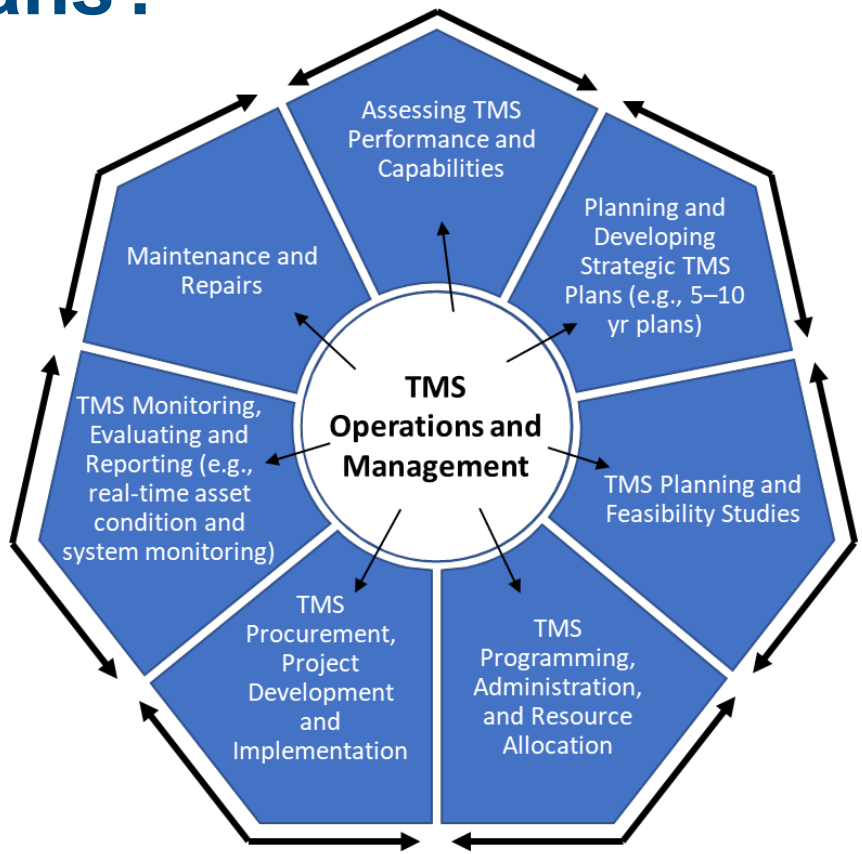
- Strategic connections—Includes functional and performance objectives and priorities for services and functions for TMS assets.
- Programmatic connections—May include staffing for operations and maintenance staff, business processes, and budgeting.
- Tactical connections—Includes financial planning and performance assessment.

What Are the Benefits of Managing TMS Assets?

- Achieving and sustaining desired performance (e.g., state of good repair).
- Managing TMS assets' lifecycles.
- Improving asset performance and thus, the overall system.
- Integrating conditions of assets and resources into how they are managed, maintained, operated, repaired, replaced, and retired.

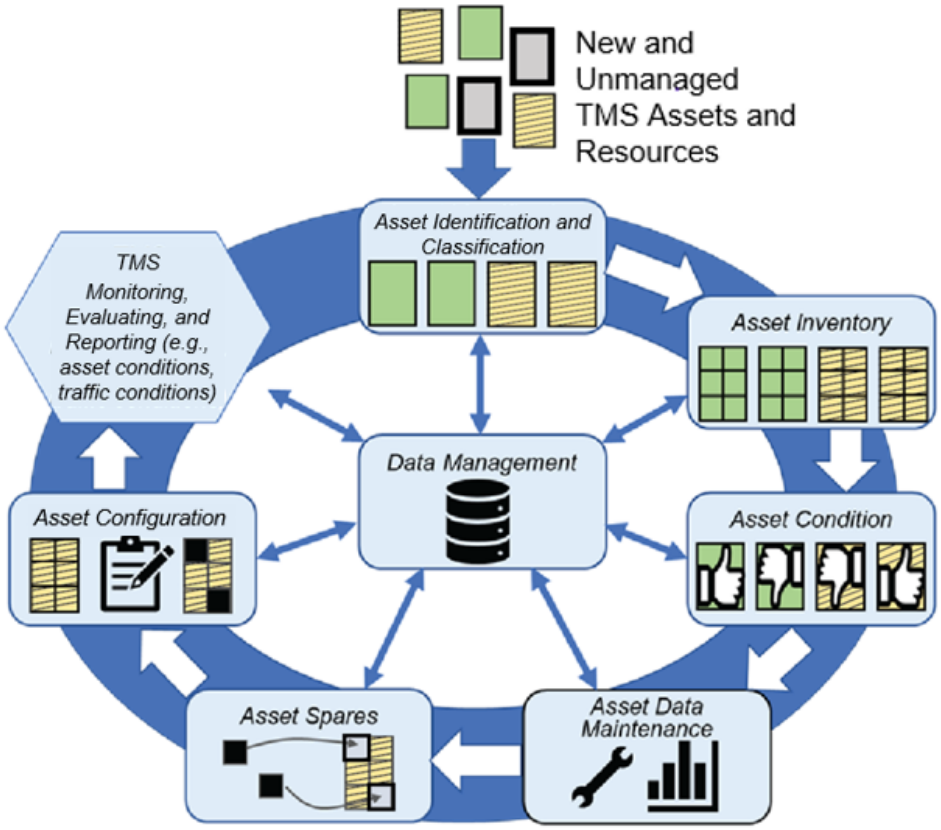
What Is the Value of Managing Assets in TMS Processes and Plans?

- Developing and managing reliable and useful data about agency TMS assets.
- Collecting, managing, and maintaining data to assess condition, performance, and needs.
- Providing information to report to various audiences.



Source: FHWA.[3]

Managing TMSs Asset Activities



Source: FHWA.[3]

TMS Asset Identification and Classification

Identifying TMS Assets

The identification process establishes the TMS assets to be managed:

- What assets can be managed:
  - Are appropriate data available?
  - Can agencies improve life expectancy and performance by monitoring their condition and taking appropriate actions?
- What assets are worth managing? Will the benefits of managing the asset exceed the resources required?
- What benefits does the agency expect to gain by managing an asset? Are objectives and targets (e.g., availability or reliability targets) defined?

Utah Department of Transportation (DOT): "The challenge in identifying assets is determining what to inventory and what not to inventory."[4]

Classifying TMS Assets

- Classification organizes TMS assets in terms of data collection, management, and analysis.
- Groups can be formed around similar functions or characteristics:
  - Risks of adverse impacts to travelers or the agency.
  - Performance measures and targets for each tier or class.
  - Condition levels and maintenance needs of assets.

Tier 1	Tier 2	Tier 3
• ATMS servers. • Database servers. • Communication servers. • Advanced traveler information servers. • ATMS software. • Primary communication media (e.g., truck fiber). • Vehicle detectors. • CMSs. • Primary communication hardware (layer three hub switches). • Overheight vehicle detection systems. • Electronic clearance. • Traffic signal controllers. • Traffic signals heads and hardware.	• CCTV surveillance cameras. • Road weather information systems. • Secondary communication media (e.g., branch fibers). • Video wall controllers. • Video monitors/projection units. • ATMS workstations. • Secondary communication hardware (e.g., layer 2 switches and edge switches). • Ramp meters. • Automated license plate reader cameras.	• Highway advisory radio. • Weigh in motion. • Emergency call boxes. • Portable signs. • Portable detectors. • Portable cameras. • Connected vehicle onboard units and roadside units.

ATMS = advance transportation management system; CCTV = closed-circuit television; CMS = changeable message signs.

TMS Asset Identification and Classification Practices

- Identify the TMS assets an agency can manage to help improve TMS performance, condition, and lifespan:
  - What activities will be performed to manage TMS assets?
  - What resources are required?
- Classify the identified TMS assets. Classification helps define how each asset is managed (e.g., critical assets will be more actively managed than noncritical assets).

TMS Asset Inventory

What Is a TMS Asset Inventory?

An inventory describes a TMS's assets and supports understanding asset condition, performance, and needs.

- Each asset is described by attributes, such as:
  - Quantity.
  - Make and model.
  - Age.
  - Location.
  - Condition.
- An inventory is limited by the data that are available and can be collected and has utility for managing the assets:
  - Not all available information has value for managing an asset.
  - Too much information may make data management overly complicated.

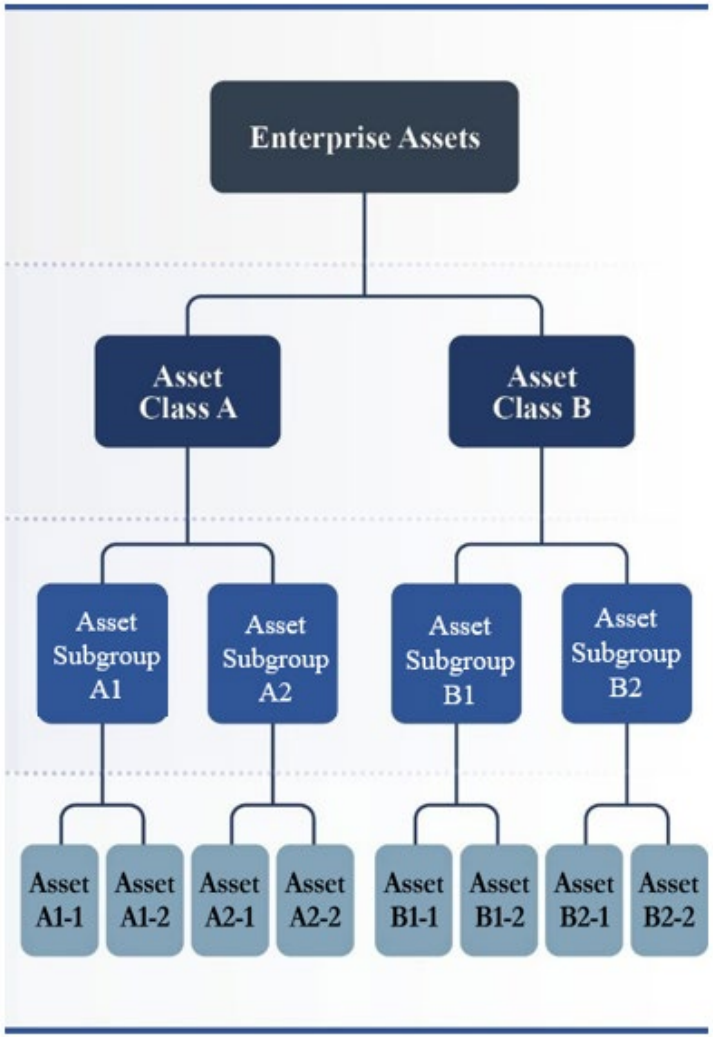
Inventory Framework[3]

Enterprise-Level Inventory: Comprehensive view of all assets owned, operated, maintained, and/or monitored by the agency. Allows for holistic understanding of the interaction between all asset classes and the relationships of the various asset classes to overall safety, mobility, and asset performance.

Asset Class-Level Inventory: A collective view of all assets within a defined asset class. Allows for analysis and understanding of the operation and maintenance of all the assets holistically within the class. Example asset classes typically include bridges, pavement, traffic signals, ITS devices, etc.

Asset Subgroup-Level Inventory: A specialized group of assets within an asset class within the same characteristics and functions, such as the type of pavement (asphalt versus concrete) or the type of ITS device (ITS cabinet, camera, dynamic message sign, RWIS, smart warning device, etc.).

Asset-Level Inventory (ITS assets): The listing of individual assets and all information tracked for these assets, including but not limited to general characteristics, inspection and condition assessment data, performance metrics, preventative maintenance plans, and work management information.

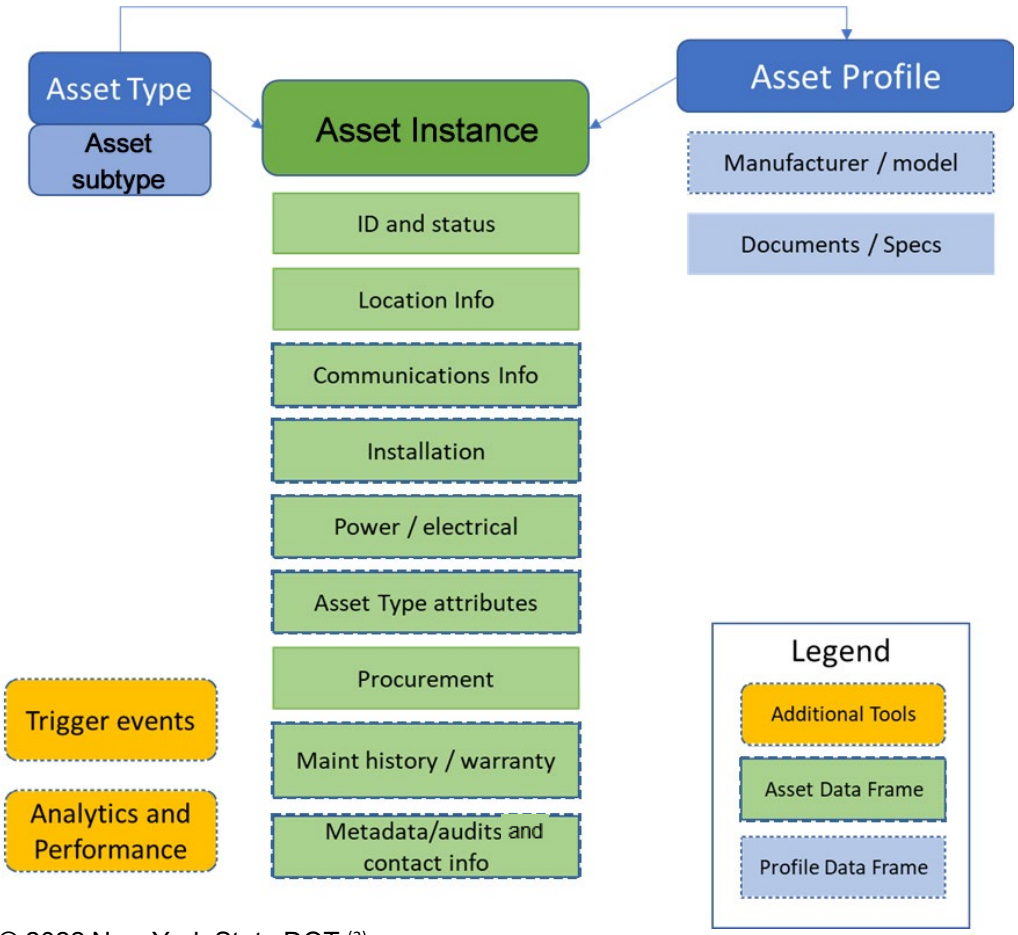


Source: FHWA.[5]

Asset Data Frame

Example of framework for defining asset inventory:

- Asset type—Correlates to subgroup and may define the type or class of the asset (e.g., camera, signal, etc.).
- Profile—Identifies information that may distinguish assets of a similar type (e.g., make and model).
- Instance—Attributes that uniquely describe each asset (e.g., location, condition, maintenance history, etc.).



ID = identification; maint = maintenance; specs = specifications.

TMS Asset Lifespan as an Attribute

Agencies are challenged to estimate the lifespans of technology assets:

- Based on manufacturer guidance (e.g., manufacturer's documented estimate or manufacturer warranty).
- Based on historical lifespans observed for various asset types.
- Derived from estimates of lifespans for different device types, by asset type.

ITS Component	Lifetime (years)
Dynamic message sign	20
Dynamic message sign—portable	14
CCTV camera	10
Highway advisory radio transmitter	20
Highway advisory radio flashing beacon	10
Electronic toll-tag reader	10
Wireless communications (high usage)	20

Estimate of TMS Asset Lifespans.[1]

[1] Interview with Pennsylvania DOT conducted on October 28, 2020.

TMS Asset Inventory Practices

- Select attributes that help:
  - Classify the assets.
  - Define the assets.
  - Provide an understanding of performance and condition.
  - Support the activities that manage the assets.
- Consider:
  - How and where inventory information is collected and stored.
  - What tools are needed to manage inventory data.
  - What practices already exist or are needed to ensure the inventory is accurate and up-to-date.

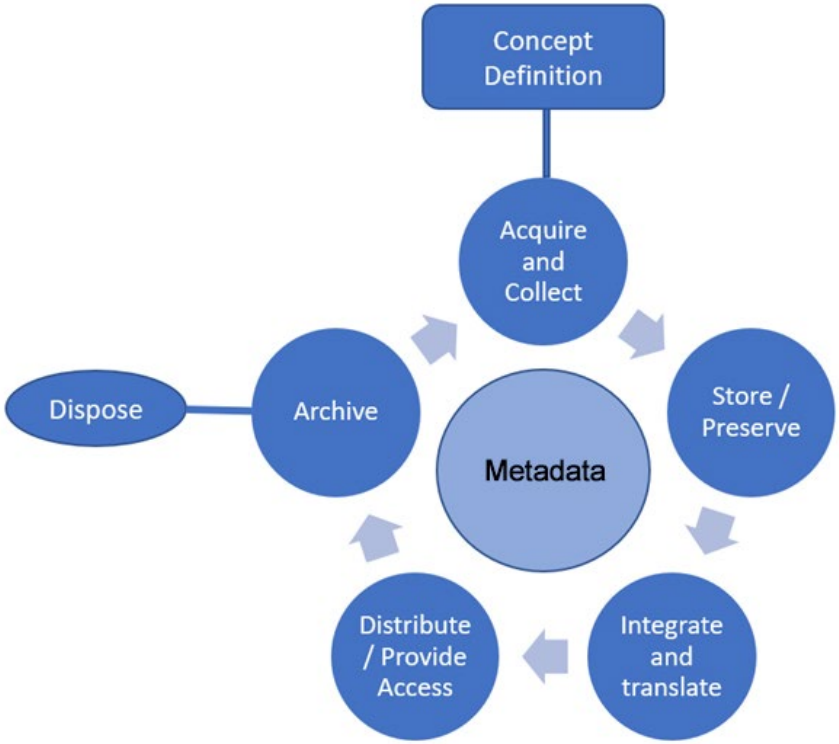
TMS Asset Data Management

What Is TMS Asset Data Management?

- Data management is the activities and resources to collect, store, and access the inventory data.
- Does the agency:
  - Know where its data reside?
  - Have processes for consistently documenting asset information?
  - Have appropriate tools for storing and using data?
  - Have access to the data (between systems and for staff)?
- Data management is the heart of managing TMS assets!

TMS Asset Data Management Activities and Resources

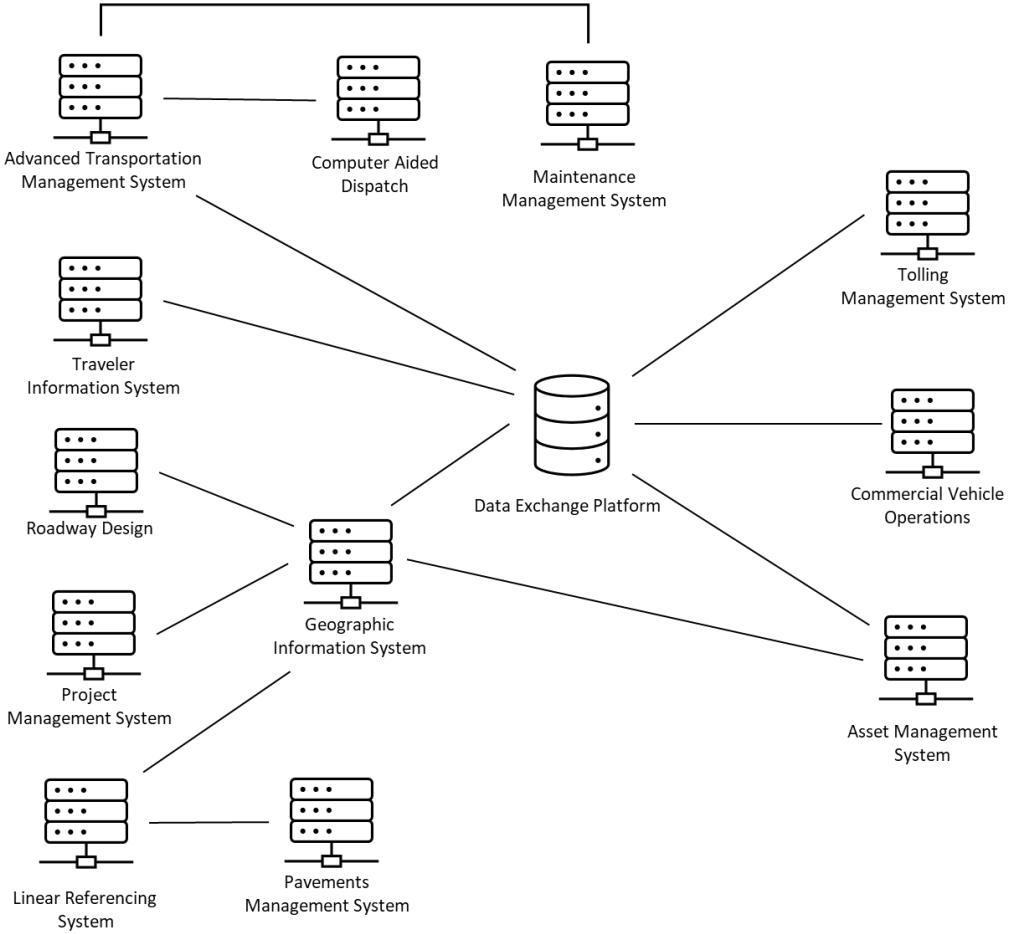
- Data principles: Does an agency already have principles in place?
- Data curation: How are data managed over the data's lifetime?
- Data quality factors:
  - What are the expectations for data quality?
  - What activities, tools, and resources are needed to meet expectations?



Source: FHWA.[3]

TMS Asset Data Management Tools

- Tools for managing TMS asset data:
  - What functions are needed?
  - What tools does the agency already have?
- Data access and sharing:
  - Is access through the tools secure?
  - Do the appropriate people and systems have access to properly manage the assets?



Source: FHWA.[3]

TMS Asset Data Management Practices

- Consider existing data management practices:
  - Do defined principles exist?
  - Does a data management plan exist?
  - What tools does the agency have, and do they meet the needs for managing TMS assets?
- Consider how data will be managed:
  - Who will collect them?
  - Who will perform data curation and ensure data quality?
  - How will data be shared?

TMS Asset Condition

Considerations for TMS Asset Condition

Condition is used to define expectations for assets:

- Agencies may consider the following in determining condition:
  - Age.
  - Performance.
  - Use.
- Condition supports understanding an asset's needs and ability to meet performance targets.
- Condition may be used to estimate maintenance and replacement.

Using Condition to Estimate Maintenance

- Condition may be used to estimate maintenance and replacement needs.
- Nevada DOT (NDOT) estimates types and probabilities for maintenance activities for assets based on age.[6]

Condition	Age
Good	Within first 80 percent of expected life.
Low Risk	Between 80 and 100 percent of expected life.
Medium Risk	Between 100 and 125 percent of expected life.
High Risk	Over 125 percent of expected life.

NDOT ITS Condition Assessment.[6]

Maintenance Type	Good Condition (percent)	Low Risk Condition (percent)	Medium Risk Condition (percent)	High Risk Condition (percent)
Inspection	100	100	100	100
Minor	—	10	30	10
Major	—	—	10	25
Replacement	—	—	—	10

—No data.

NDOT Maintenance Needs for Cameras by Condition.[6]

Data That Support Assessing Condition

- Data collected during procurement:
  - Specifications, make and model, operating systems, and firmware.
  - Dates of procurement (age).
  - Manufacturer guidance on maintenance and expected lifespan.
- Maintenance history over the lifespan of the asset:
  - Maintenance activities.
  - Configuration changes and verification.
- Operational status of the asset:
  - Mean time to failure.
  - Percentage of time the asset is available and providing its functions.
  - Frequency of failure.
  - Work orders.

TMS Asset Condition Practices

- Consider previous experience:
  - What attributes have proved accurate in assessing condition (e.g., age, use, maintenance history)?
  - Is the condition of an asset defined by the condition of one of its elements (e.g., is the logic board a common failure point in a sign)?
- Consider the availability and quality of data:
  - Are data recorded consistently?
  - Does a clear definition exist for each condition (e.g., good, fair, poor)?
- Define condition to support managing assets:
  - NDOT estimates maintenance needs based on condition.[6]
  - Condition and asset class may help identify maintenance priorities.

TMS Asset Data Maintenance

What Is TMS Asset Data Maintenance?

- Management involves collecting, storing, and sharing asset data.
- Maintenance involves keeping that data accurate:
  - How have the assets changed?
  - What maintenance has been done to the assets?
  - How have expectations for the asset changed?
- Maintenance supports data quality and provides an accurate view of the assets, including their conditions, performance, and needs.
- Current and historical asset data have value in establishing expectations for an asset.

Considerations for TMS Asset Data Maintenance

- Establishing data collection early in an asset's life:
  - Creates a baseline of an asset's composition.
  - Documents the performance expectations for evaluation through the asset's lifetime.
- Integrating changes to assets into data collection and management:
  - Documents changes in composition and expectations.
  - Tracks the impact of changes on condition and performance.
- Governing the data:
  - Ensures consistency in data maintenance.
  - Defines roles and responsibilities.

Data Governance

The Florida DOT (FDOT) Reliable, Organized, Accurate, Data Sharing (ROADS) data governance initiative is organized around:[7]

- People.
- Processes.
- Technology.

TMSs Asset Data Maintenance Practices

- Maintain data over assets' lifecycles:
  - Assets change over time, and so will the expectations for the assets.
  - Data accuracy supports maintenance and condition assessment.
- Data governance supports data maintenance:
  - Establish data maintenance roles and responsibilities.
  - Define how data tools and processes will be used to keep data up-to-date.

TMS Asset Spares and Support Resources

The Role of Spares in Managing TMS Assets

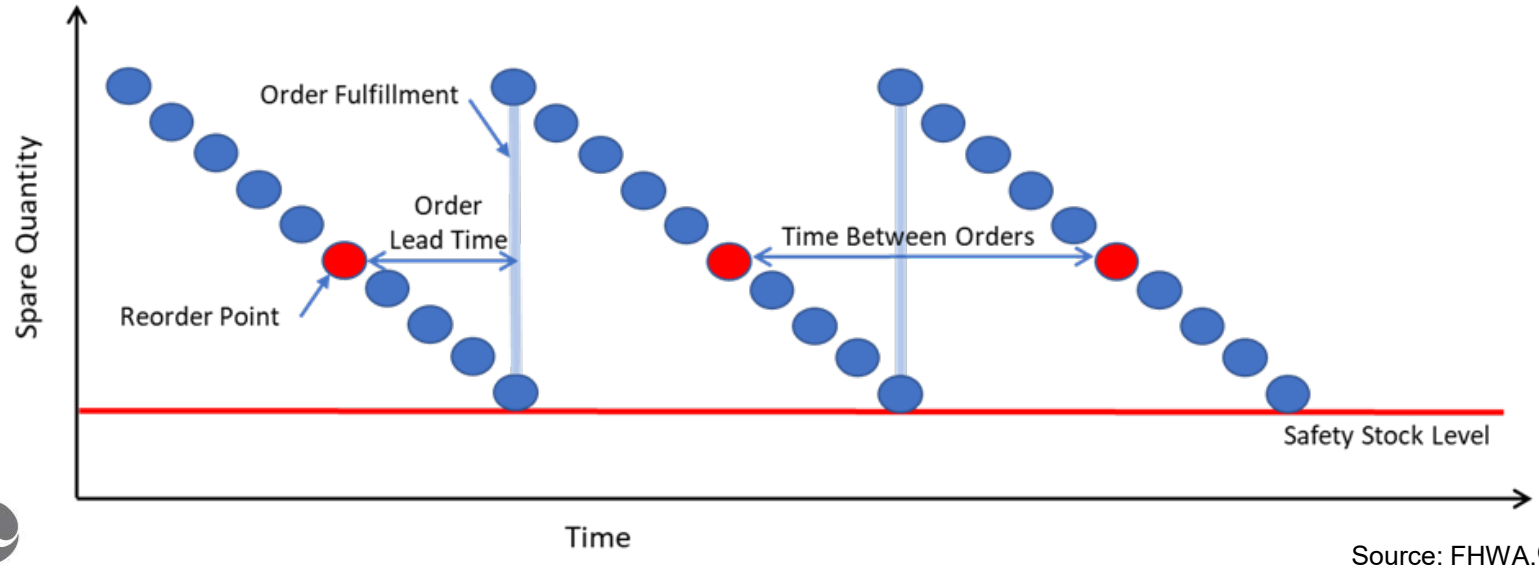
Spares are replacement components and devices that can be repaired or swapped:

- Having spare parts in the right quantities, in the right places, and at the right times supports keeping assets operational.
- To have spares available, agencies may:
  - Contract with vendors to ensure spares will be available.
  - Arrange for just-in-time delivery of spares.
  - Plan to store and inventory spares.

Forecasting the Need for Spares

Considerations in spare forecasting:

- How often are spares used?
- How long does the procurement process take?
- How critical are the spares, and how many are needed in the case of widespread failures?
- When can an agency procure spares (funding availability, budget schedules)?



Source: FHWA.[3]

TMSs Asset Spares and Resource Practices for Support

Agencies may want to consider the following practices:

- Require the availability of spares for the lifespan of assets during procurement.
- Consider the class of the assets in determining the need for spares.
- Factor in procurement, budget cycles, and delivery times when planning spare inventories.
- Consider just-in-time delivery or vendor storage for fragile spares.
- Use data management tools to track the usage and availability of spares.

TMS Asset and Resource Configuration

What Is Configuration Management?

The Configuration Management for Transportation Management Systems Handbook defines configuration management as:[8]

> *Programs and plans provide the technical and administrative direction to the development and implementation of the procedures, functions, services, tools, processes, and resources that are required for the successful development and support of a system.*

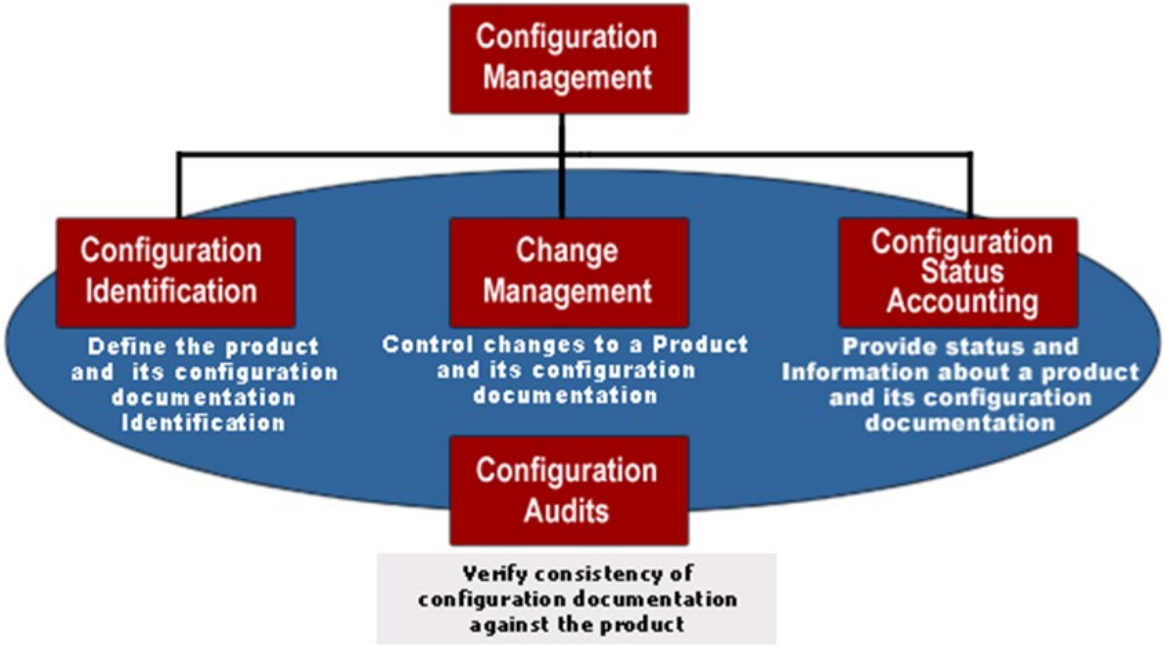
TMS Asset Configuration Management

Configuration management documents and manages changes to TMS assets, such as a changes in operating systems or the installation of a spare. Configuration management can do the following for agencies:

- Provide history on what a TMS asset has been previously and information on what the asset is currently composed of.
- Verify TMS assets are as expected or identify how they have changed.
- Result in better understanding of TMS assets—Inventory, history, condition, and performance expectations.

Configuration Management Processes in Managing TMS Assets

- Having uniform identifiers for assets across tools and resources.
- Understanding when and why changes are made and by whom.
- Incorporating change documentation and verification into existing processes (e.g., maintenance activities).
- Tracking changes to assets in data management tools.



Source: FHWA.[3]

TMSs Assets and Resource Configuration Practices

- Consider whether a configuration management plan exists:
  - Who performs configuration management?
  - Are TMSs assets included in the plan?
  - What activities are in the configuration management plan, and how do they align with the activities for managing assets?
- Capture metadata about assets:
  - Who made changes, and when?
  - Why were changes made?
- Incorporate configuration into existing activities:
  - TMS asset configuration of field devices can be verified during maintenance.
  - Configuration can be documented from procurement through asset retirement.

TMS Asset Monitoring, Evaluating, and Reporting

What Is the Role of Monitoring, Evaluating, and Reporting TMS Assets?

Monitoring, evaluating and reporting uses a TMS's asset data management tools to inform on condition, performance, and needs:

- Monitoring assets provides an agency with realtime information about asset statuses.
- Using asset data allows agencies to evaluate condition and performance and compare these results to targets.
- Reporting asset data synthesizes data for reports to various audiences on condition, performance, and needs.

Monitoring TMSs Assets

- Existing tools and available data may provide monitoring capabilities (e.g., network monitoring or advanced transportation management systems).
- The appropriate level of detail for the data may differ by asset class (e.g., does a highway advisory radio on a remote road need to be monitored as frequently as an urban changeable message sign?).
- Monitoring may be performed as part of the roles of traffic management center operators and information technology and maintenance staff.

Asset Attributes	Collection Frequency
Device up/down availability	Once every 5 min.
Over-temperature alarms	Once every 5 min.
Humidity alarms	Once every 5 min.
Pixel/lamp errors	Once every 5 min.
Power errors	Once every 5 min.
Communication errors	Once every 5 min.
Fan alarms	Once every 5 min.

Example Monitoring Frequency for a Changeable Message Sign.[9]

Evaluating TMSs Assets

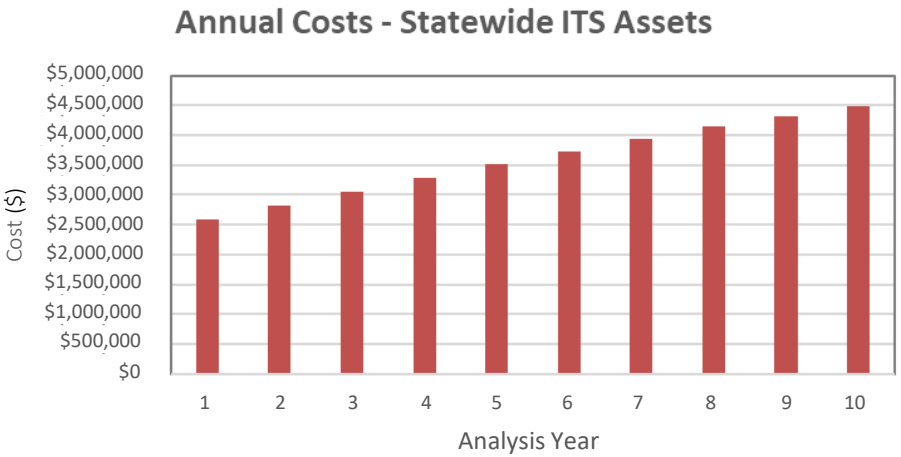
- In evaluating assets, an agency compares its data to its expectations.
- An agency requires performance measures that use asset data.
- Agencies may consider the following during evaluation:
  - Are the measures appropriate for the asset classification?
  - Are the measures linked to the agency's overall performance goals?
  - Can the measures be evaluated?
  - Are the measures understandable?

Examples of measures:[9]

- Asset health, uptime, and reliability.
- Mean time between failures.
- Mean time to repair.
- Malfunction and issue type.
- Repairability.
- Cost to maintain.

Reporting on TMS Assets

- Reporting uses asset data to tell others about:
  - Condition and performance—Are the assets meeting targets? Why or why not?
  - Needs—Maintenance, resources, or additional assets to meet targets.
  - Costs and value—How much is being spent or will be spent?
- Reporting is different for each audience:
  - Decisionmakers may want high-level summaries—How much will it cost?
  - Operational staff may want to know TMS condition and performance.
  - Maintenance may want specific device or component information.



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TMS Asset Monitoring, Evaluating, and Reporting Practices

- Consider the monitoring activities already performed:
  - What data are encountered in a TMC by maintenance and information technology staff?
  - Are the resulting data collected? What, if any, processes exist on how to use that data?
- Consider evaluation when data is collected, managed, and maintained. Accurate evaluation relies on quality data that provide meaningful information on TMS asset performance, condition, and needs.
- Consider the audience when reporting:
  - Quality data can be “rolled up” to different levels of detail, depending on the audience.
  - What does the audience need to know, and how can the agency’s asset data inform them?

TMS Resources

- TMC PFS website.[10]
- National Operations Center of Excellence (NOCoE) TMS portal.[11]
- Next Generation of TMSs Resources.[12]

TAM Resources

- FHWA Asset Management Portal.[13]
- Managing TMS Assets.[3]
- *Applying Transportation Asset Management to Intelligent Transportation Systems Assets: A Primer*.[14]
- *Applying Transportation Asset Management to Traffic Signals: A Primer*.[15]
- *Handbook for Including Ancillary Assets in Transportation Asset Management Programs*.[16]

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