Establishing and Using a Traffic Management System Inventory

Transportation Management Center (TMC) Pooled-Fund Study

Federal Highway Administration (FHWA)

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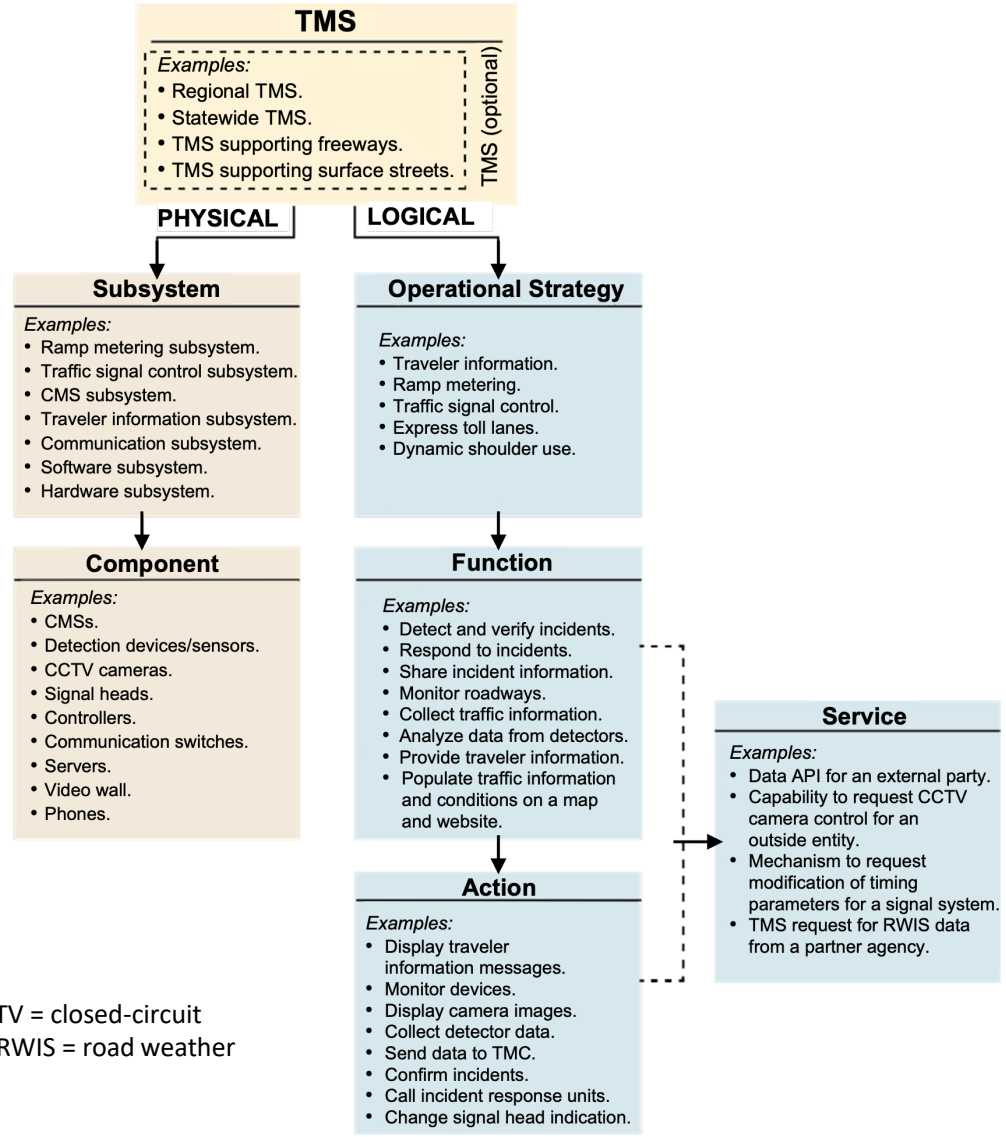
TMSs

TMS design and structure can be divided into physical elements and logical elements.

- The physical elements are the subsystem and the components.
- The logical elements are operational strategies, functions, actions, and services.



API = application programming interface; CCTV = closed-circuit television; CMS = changeable message sign; RWIS = road weather information system.

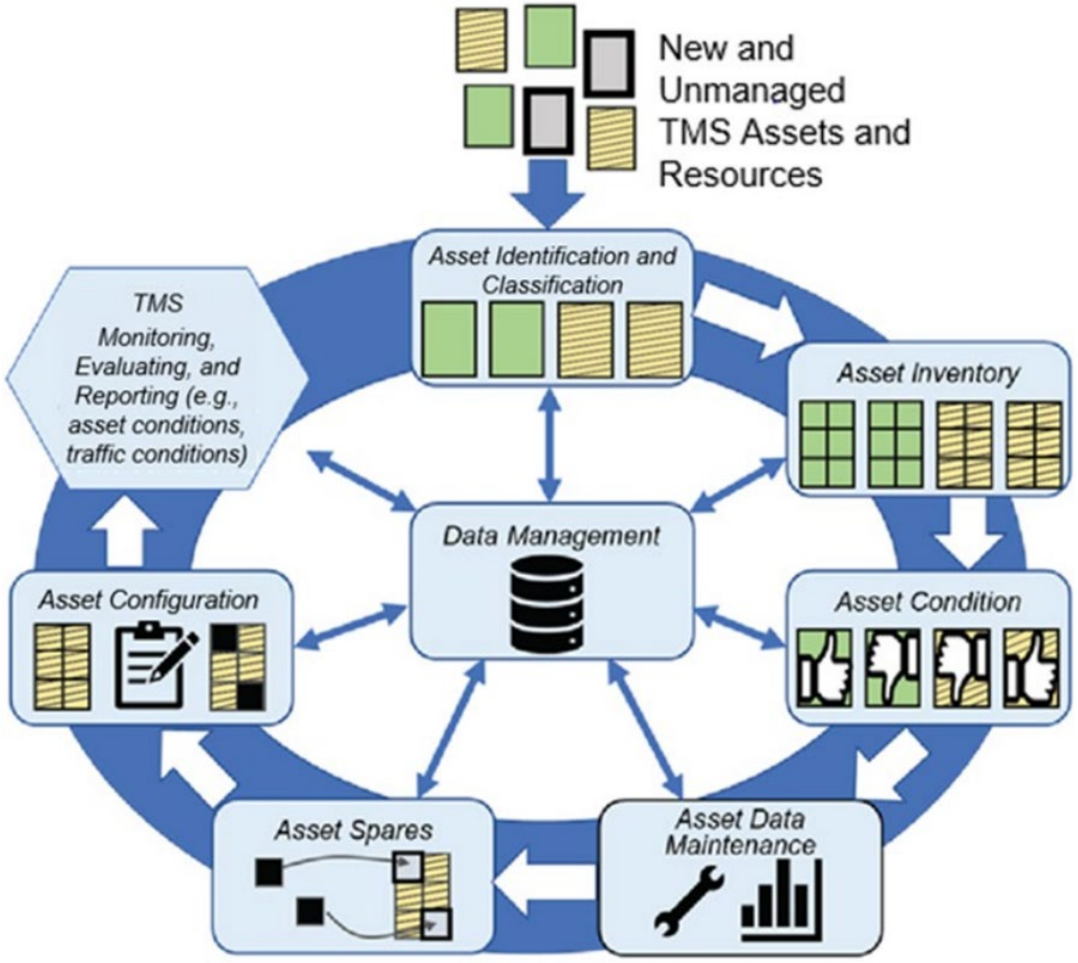
Note: The solid lines show the internal system hierarchy, and the dashed lines show the need for connection to external systems.

Source: FHWA.[1]

Managing TMS Assets

Activities conducted throughout the TMS lifecycle to manage assets may include:

- Preparing to manage TMS assets
- Managing TMS asset data, which includes identifying, classifying, and inventorying
- Maintaining TMS asset data, which includes condition rating, data maintenance, asset spare management, and management of the configuration of assets
- Monitoring, evaluating, and reporting on TMS assets



Source: FHWA.[2]

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, can be collected, and have utility for managing assets:
  - Not all available information has value for managing an asset
  - Too much information may make data management overly complicated

Why May an Agency Need an Inventory?

- Provides accurate data for TMS monitoring, evaluating, and reporting processes
- Yields key information about the agency's TMS assets, such as status, condition, performance, and needs
- Supports informed decisionmaking about assessing, managing, and operating TMS assets
- Feeds into various TMS planning activities, plans, and other processes throughout the lifecycle of the TMS
- Helps identify gaps in the current system and make decisions about asset maintenance and replacement

What Resources Might an Agency Include in an Inventory of TMS Assets?

- Resources are non-physical assets that support management and operation of TMSs
- Including resources provides a more comprehensive view of the assets and supporting elements that make up the TMS
- Resources help agencies understand the full scope of what they have available to support effective TMS management and operation
- Resources support informed decisionmaking about resource allocation and use
- Resources ensure important supporting documentation and information on TMS are readily available when needed

Example of TMS Assets and Resources to Inventory(1)

Assets

- CCTV cameras
- Traffic signals
- Traffic detectors
- Ramp meters
- Cabinets
- Controllers
- Databases
- Telecommunications subsystems
- Software applications
- Changeable message signs

Resources

- Policies affecting TMS assets
- Maintenance of operations contracts
- Standard operating procedures
- Maintenance processes documentation
- Device specifications and warranties
- Data sources
- Device configuration settings
- Work order details
- Software changelogs
- Device performance history

Benefits of Creating an Inventory of TMS Assets[(2)]

- Supports effective management of TMS assets
- Informs planning for TMS improvements and day-to-day operations
- Facilitates efficient TMS asset maintenance and repairs
- Aids in procuring individual TMS elements
- Enables understanding of asset quantities, conditions, and age
- Supports obtaining resources to bolster TMS enhancements

Current TMS Inventory Practices[2]

- When initiating a new inventory or updating an existing inventory, an agency may select asset attributes that help:
  - Classify and define the assets
  - Provide an understanding of performance and condition
  - Support the activities that manage the assets
- When deciding to create an inventory or expand a current inventory, an agency may 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

Challenges With Creating an Inventory TMS Assets(1)

- Starting the effort and obtaining necessary resources
- Updating or enhancing the inventory through the course of time
- Maintaining inventory information and keeping it current
- Incorporating tasks to update the inventory as part of existing processes
- Sustaining the resources to support, manage, and maintain the TMS asset inventory

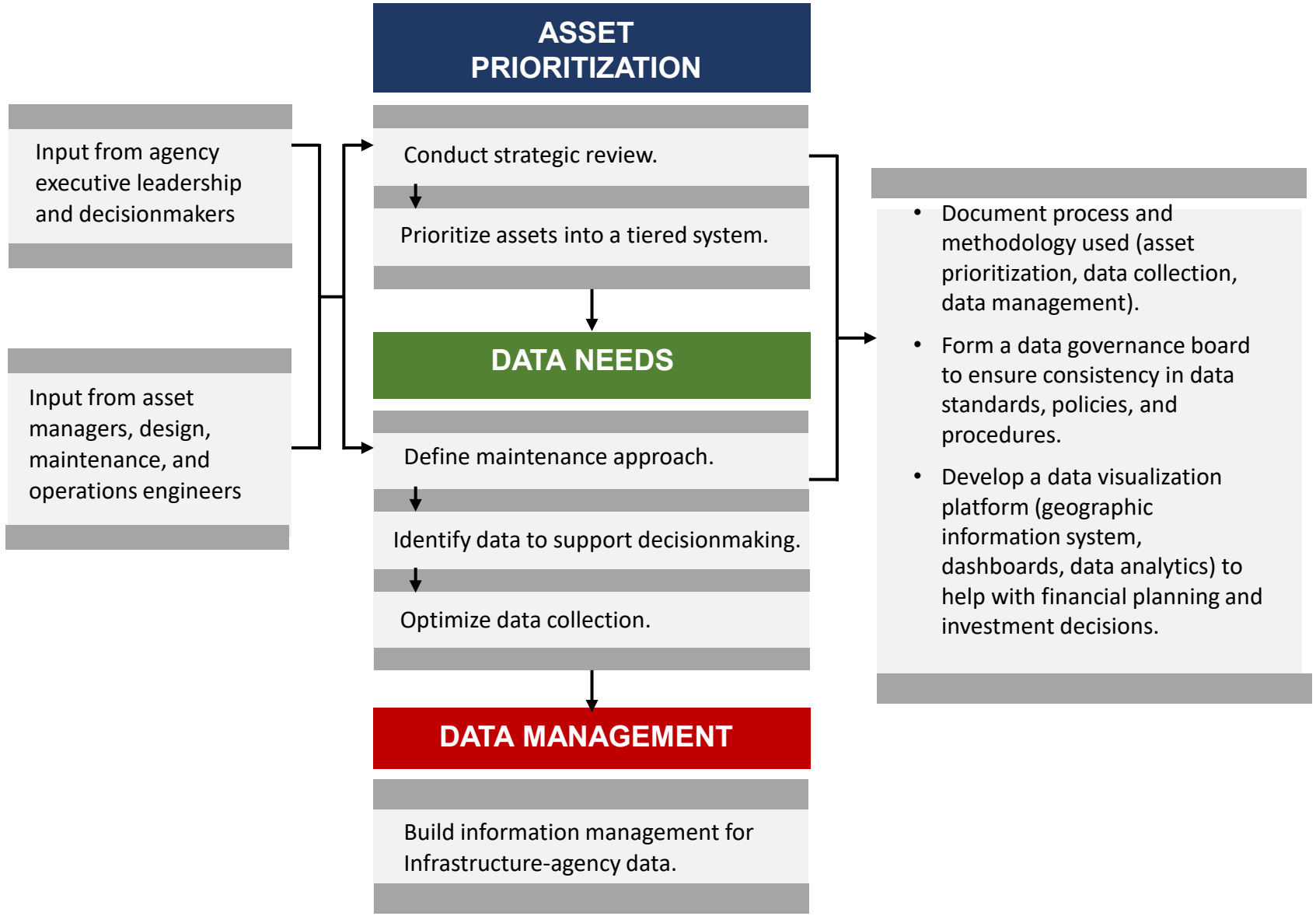
Planning for a TMS Asset Inventory(1)

- Assess the type and quality of data available or that can be easily collected.
- Determine potential return on investment from creating—or updating and managing—an inventory of TMS assets.
- Evaluate the ability to integrate TMS inventory with other agency processes.
- Analyze the resource requirements for current inventory management and future inventory enhancements.
- Project ongoing resource needs for maintaining inventory information and system to collect, compile, and manage use.
- Plan for effective access and use of the inventory across the agency.

Factors for Prioritizing TMS Assets and Resources to Inventory(1)

- Importance of assets to existing TMS operations
- Asset condition information for monitoring, maintenance, and repair
- Data collection effort and cost of TMS asset information
- Ongoing cost to maintain and update TMS asset information
- Anticipated application and value of TMS asset information
- Impact on future TMS planning and decisionmaking

Example of Process to Select TMS Assets to Inventory

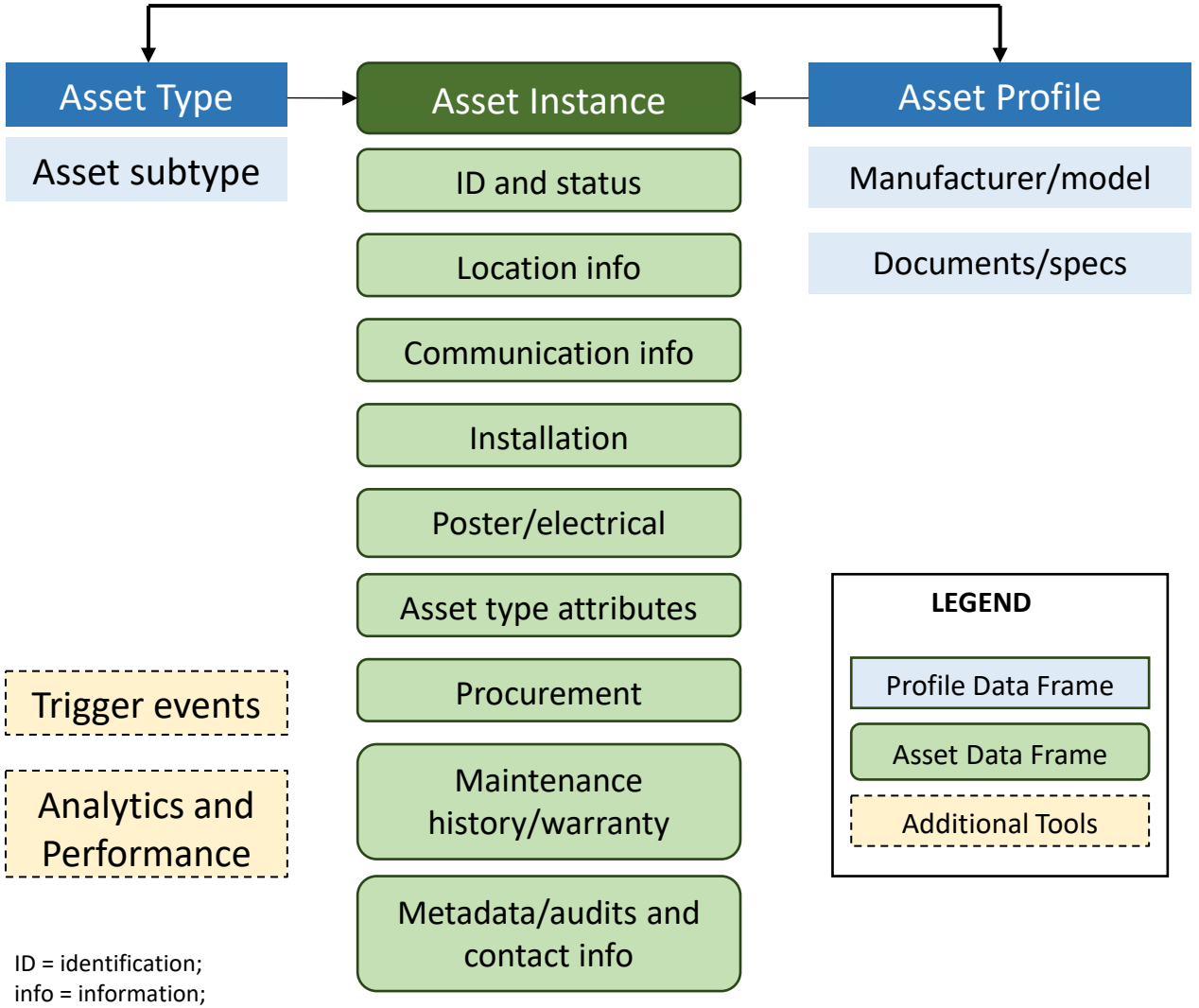


Source: FHWA.[3]

Considerations for Selecting TMS Assets to Inventory

Example of framework for defining asset inventory:

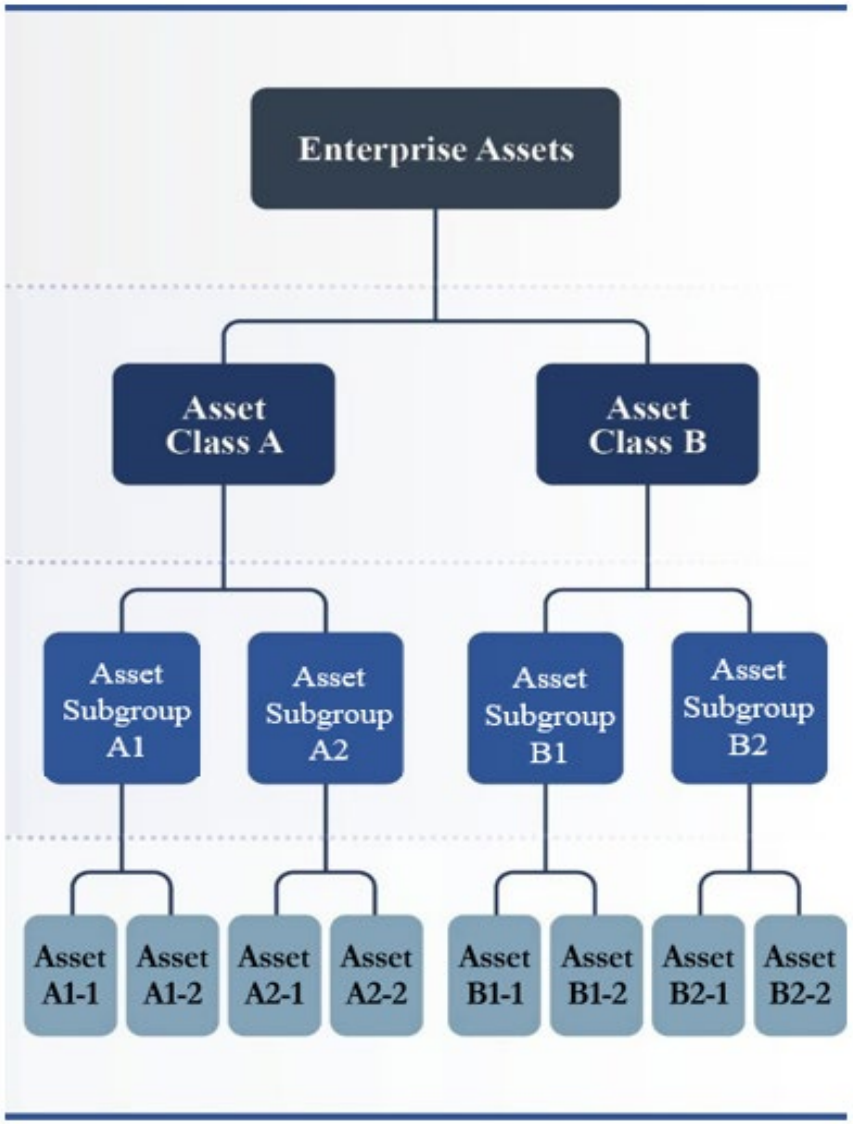
- Asset type—Correlates to subgroup and may define the type or class of the asset (e.g., camera, signal)
- Profile—Identifies information that may distinguish assets of a similar type (e.g., make and model)
- Instance—Attributes that uniquely describe each asset (e.g., location, condition, maintenance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



ID = identification;
info = information;
specs = specifications.

Classifying TMS Assets

- Categorize assets into logical groups such as hardware, software, or location
- Establish tiers based on operational importance or maintenance needs
- Use classification to prioritize data collection and maintenance efforts
- Apply consistent performance measures for assets in the same class
- Align classifications with intended use of inventory data



Source: FHWA.[4]

Considering TMS Asset Tiers[(1)]

Tiers reflect asset importance and maintenance priorities:

- Tier 1:
  - Asset is critical to system operations
  - Minimal downtime is acceptable
  - Asset has dedicated, prioritized funding
- Tier 2:
  - Asset is highly beneficial to system operations
  - Device is repaired within reasonable timeframes
- Tier 3:

  Asset downtime is not detrimental to system operations

Example: TMS Asset Tiers(1)

TMS assets and resources grouped by importance, impact of downtime, and maintenance priorities.

Tier 1	Tier 2	Tier 3
• TMS servers • Database servers • Communication servers • Advanced traveler information servers • TMS software • Primary communication media • Vehicle detectors • Dynamic message signs • Primary communication hardware (e.g., layer 3 hub switches) • Over-height vehicle detection systems • Traffic signal controllers • Traffic signal heads and hardware • Device settings and configurations	• CCTV cameras • RWISs • Secondary communication media (e.g., branch fibers) • Video wall controllers • Video monitors and projection units • TMS workstations • Ramp meters	• Highway advisory radios • Weigh-in-motion stations • Emergency call boxes • Portable signs • Portable detectors • Portable cameras • Connected-vehicle onboard units and roadside units

Selecting TMS Asset Attributes(1)

- Asset attributes capture unique characteristics for each TMS asset
- Attributes can be grouped by asset type, profile, and instance data:
  - Type: Categorical information such as component or subsystem
  - Profile: Shared characteristics such as make or model
  - Instance: Specific physical asset details such as ID or location
- Aligning attributes with asset tiers can help prioritize data collection
- Selection of attributes is based on value for asset management

Considerations for Selecting TMS Asset Attributes

- Assess value of attributes for managing assets
- Prioritize attributes that inform maintenance, investments, and performance
- Evaluate costs of initial data collection and ongoing updates for each asset
- Implement quality control for data

- Example asset attributes:
  - Location
  - Installation date
  - Most recent service date
  - Asset condition
  - Functional description
  - Make and model
  - Serial number
  - Purchase cost
  - Maintenance costs
  - Firmware version

Example TMS Assets' Attributes(5)

Area	Attribute	Field Devices	Communication and Networking	Hardware and Software	Portable
Inventory	Functional description	Y	Y	Y	Y
Inventory	Make and model	Y	Y	Y	Y
Inventory	Serial number	Y	Y	Y	Y
Inventory	Specifications	Y	Y	Y	Y
Inventory	Quantity	Y	Y	N	Y
Inventory	Components	Y	Y	N	Y
Inventory	Capital costs	Y	Y	Y	Y
Inventory	Contract and warranty	Y	Y	Y	Y
Inventory	Status	Y	Y	Y	Y
Location	Physical location	Y	Y	Y	N
Location	Physical environment	Y	Y	N	N
Location	Vehicle information	N	N	N	Y
History	Procurement date	Y	Y	Y	Y
History	Deployment date	Y	Y	Y	Y
History	Performance history	Y	Y	Y	Y
History	Maintenance history	Y	Y	Y	Y
History	Maintenance and operations costs	Y	Y	Y	Y
History	Condition	Y	Y	Y	Y
System environment	Software and firmware	Y	N	Y	Y
System environment	Hardware	Y	N	Y	Y
System environment	Licenses	Y	Y	Y	Y
Infrastructure	Infrastructure	Y	Y	N	N
Infrastructure	Utilities	Y	Y	N	N
Infrastructure	Enclosures	Y	Y	N	N

N = no; Y = yes.
Note: Gray cells indicate asset attributes not included in the inventory.

Initiating an Effort to Create an Inventory of TMS Assets(1)

Items to consider when initiating an effort to create an inventory of TMS assets:

- Review existing asset information, inventories, or related data that could be expanded
- Determine inventory scope based on system size, complexity, and intended use
- Select TMS assets and resources to inventory
- Select TMS asset attributes to include
- Plan for data management, access, and maintenance responsibilities

Reviewing Potential Existing Inventory Information

When reviewing potential existing inventory data or related information, an agency may consider the following example sources or systems:

- Enterprise asset management inventory:
  - A subset of TMS or intelligent transportation system (ITS) assets may already be incorporated.
  - The inventory is unlikely to be a thorough list of TMS assets.
- Existing spreadsheets of TMS asset information
- TMS databases containing TMS asset information
- Web-based software system tracking-device details

Example of TMS Assets to Consider (1/2)[(1)]

When an agency is selecting assets to include in the TMS inventory, these are example assets to consider:

Asset Class/Asset Type	Asset Examples
Field devices/cameras	CCTV traffic cameras Video detection Camera: RWIS
Field devices/connected and automated vehicles	Roadside units Antennas
Field devices/highway advisory radios	Broadcast units
Field devices/message signs	Dynamic message signs Queue warning signs Blank-out signs Sign controllers Portable changeable message signs

Example of TMS Assets to Consider (2/2)[(1)]

Asset Class/Asset Type	Asset Examples
Field devices/sensors	Traffic detectors Commercial vehicle dimension wireless data collectors Weigh-in-motion stations Roadway intersection conflict warning systems
Field devices/RWIS	Environmental sensing stations Non-invasive pavement sensors Road sensors
Field devices/traffic control	Controllers Gates Lane controllers Preemption signals Ramp meters Reversible lane signs Signals Variable-speed-limit signs Warning flashers Device settings and configurations
Field devices/traffic detection	Detectors

Sustaining an Inventory of TMS Assets(1)

To sustain an inventory effort, an agency may consider:

- Maintaining inventory accuracy
- Managing impact on agency resources
- Integrating with existing processes
- Implementing ongoing quality assurance processes
- Updating inventory information during routine asset maintenance processes
- Providing easy access to historical asset information for operations and maintenance staff

Resources to Consider for Sustaining a TMS Asset Inventory(1)

- Staff time to collect new asset information
- Staff time to manage the TMS asset inventory
- Staff or contractor time to maintain asset information through ongoing daily operations and maintenance efforts
- Staff time for quality assurance of inventory information
- Staff time to incorporate changes made to assets into the TMS asset inventory

Managing the Use of Inventory Information(1)

- Multiple people entering data into the same inventory
- Data integrity, quality assurance, and quality control processes
- Update TMS asset data and information
- Assignment of clear responsibilities for inventory updates
- Establishment of a routine update schedule for inventory updates

Maintaining TMS Inventory Accuracy(1)

- TMSs are constantly undergoing changes and upgrades
- TMS assets are frequently updated, replaced, or modified
- Maintaining inventory accuracy requires agency resources:
  - Assignment of data quality assurance and quality control responsibilities
  - Data governance practices
  - Interface management (tools for updating and controlling inventory data)
  - Regular audits of inventory information
- Without accurate inventory information, the benefits of an inventory are hindered

Ensuring TMS Inventory Accuracy and Currency[(1)]

- Implement automated processes to capture and update inventory data:
  - Integrate inventory updates into existing processes
  - Leverage tools to streamline data entry and validation
- Establish regular audits and verification processes:
  - Assign responsibilities for reviewing inventory data
  - Conduct periodic checks for completeness and accuracy
- Document standard operating procedures for inventory management, with clearly defined roles, responsibilities, and processes

Example Ensuring Inventory Accuracy: VDOT

- Virginia DOT (VDOT) uses randomly generated inventory reports to review asset inventories.(1)
- Five to 10 percent of inventoried assets are randomly selected.
- VDOT staff manually reviews asset information (e.g., location and status) and compares it with device information contained in the inventory).(2)
- Discrepancies are tracked and root causes mitigated when necessary.
- Processes are improved and maintained, which improves TMS inventory accuracy.

[1] Virginia DOT interview, 2021.
[2] Ibid.

Assessing TMS Asset Inventory: Questions

- Evaluate existing TMS asset inventory practices:
  - What assets are currently inventoried and in how much detail?
  - How current and accurate is the existing inventory information?
  - What processes are in place to keep the inventory up-to-date?
- Identify gaps and areas for improvement:
  - Which critical TMS assets are not currently inventoried?
  - What key information is missing for effective asset management?
- Use assessment insights to inform inventory planning and updates:
  - Prioritize assets and data elements to add to the inventory
  - Identify process changes needed to improve accuracy

Opportunities to Create or Update an Inventory

- When completely replacing or upgrading a TMS, capture new asset details during TMS upgrades.
- When enhancing an existing TMS, document the new capabilities and components being added.
- As TMS assets get replaced or repaired, update asset records with maintenance details.
- When updating TMS-related processes or procedures, incorporate asset updates into revised processes.

Incorporating TMS Asset Information into TMS Operations(1)

- Incorporating inventory information during asset procurement
- Updating inventory information during routine asset maintenance processes
- Integrating device status alerts into ATMS software subsystems
- Providing easy access to historical asset information for operations and maintenance staff

Incorporating Inventory Practices into Agency Planning(1)

- Including TMS asset information in the agency's transportation asset management program or plan:
  - Including TMS assets in the enterprise inventory
  - Establishing TMS asset condition and performance targets
  - Incorporating TMS inventory into asset lifecycle planning
- Leveraging TMS inventory information for TMS program plan and process to allocate resources
- Including TMS inventory information in transportation systems management and operations program planning

Opportunities to Use Inventory Information(1)

- Optimize TMS operations:
  - Expedite troubleshooting and repairs with access to historical data
  - Make informed decisions about routine actions on real-time asset status
  - Adapt quickly to events by integrating asset data into network monitoring
- Enhance maintenance and asset management:
  - Prioritize maintenance activities based on importance and condition
  - Identify trends and patterns in asset performance
- Support TMS planning and enhancements:
  - Analyze asset lifecycle costs and reliability to optimize replacement strategies
  - Justify funding requests, and prioritize projects based on asset needs
  - Identify integration requirements for new technologies

Using TMS Inventory Information in Key Processes

- Maintenance and repair processes:
  - Prioritize maintenance activities based on asset condition
  - Automatically generate work orders when asset performance issues are identified
- Technology procurement and deployment:
  - Identify outdated assets in need of replacement based on inventory data
  - Evaluate compatibility of new technologies with existing system configuration
- System monitoring and performance reporting:
  - Correlate asset condition with overall system performance metrics
  - Document asset changes and impacts through the course of time
- Strategic planning and budgeting:
  - Analyze asset lifecycle costs and failure rates to optimize refresh cycles
  - Develop long-range plans accounting for asset dependencies and integration needs

Inventory and Management of TMS Assets

Additional Resources

- The Evolution of ITS in Transportation Asset Management[5]
- Managing TMS Assets[2]
- Handbook for Including Ancillary Assets Transportation Asset Management Programs[3]

TMS Resources

- National Operations Center of Excellence TMS Portal[6]
- Transportation Management Center (TMC) Pooled-Fund Study website[7]
- Next Generation of TMS Resources[8]

References

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Questions?

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