General Active Transportation Infrastructure Specification (GATIS) v1 DRAFT

1.0 Introduction

This specification (tentative working name "General Active Transportation Infrastructure Specification" or "GATIS") seeks to establish a consistent national format for data that represent "Active Transportation Infrastructure." GATIS defines active transportation infrastructure as the surface infrastructure used by people of all ages and abilities traveling outside of motor vehicles and transit. This includes infrastructure for people walking, bicycling, using micromobility (any small, low-speed, human or electric-powered transportation device), and people who travel with the aid of assistive mobility devices like wheelchairs, walkers, and canes.

GATIS is the product of a national collaboration (hereafter referred to as "the collaboration") of public, private, and nongovernmental participants that was originally convened by the U.S. Department of Transportation's (USDOT's) Bureau of Transportation Statistics (BTS). It was created through a collaborative process and is maintained by ORGANIZATION through community consultation. GATIS is fully voluntary, and any agency or other user may elect to adopt the specification at their discretion.

1.1. Statutory Basis

BTS maintains the National Transportation Atlas Database (NTAD) as required in statute under Title 49 U.S.C. § 6309. NTAD comprises a collection of national geospatial datasets of modal and intermodal transportation facilities and networks; flows of people, goods, vehicles, and crafts over the transportation networks across all modes; and social, economic, and environmental conditions that affect or are affected by the transportation networks. To date, NTAD lacks robust datasets on the transportation facilities and networks for people traveling via active transportation. BTS convened the collaboration to establish a common data format for active-transportation infrastructure that could facilitate the broader production and use of those data by a range of public, private, and nongovernmental entities.

1.2 Goals

The purpose of GATIS is to facilitate consistency and interoperability across data producers, managers, and users within the United States. It is designed with active transportation travelers of all ages and abilities in mind. It can be used in all contexts, from rural, to suburban, to urban.

GATIS is also designed to address gaps in existing standards and specifications by capturing the attributes of active transportation infrastructure that are critical for preference-based routing, planning, engineering, safety analyses, and improved asset tracking and maintenance, among other use cases. Refer to Definitions for descriptions of key terms.

1.3 Guiding Principles

Guiding principles shape GATIS' development and ongoing evolution by specifying an intended purpose, audience, governance, and requirements. Voting members of the collaboration approved the guiding principles, which may be revised or updated as needed through the Collaboration Framework or any governance processes that might replace it in the future. The seven current guiding principles, along with clarifying information about each, follow:

1. **The specification is owned and openly governed by the community.**
    - The specification is licensed under CC0 1.0 Universal Public Domain.
    - A defined governance process for this specification exists to guide changes and other processes (refer to Governance).
2. **Data produced under the specification should be shared freely and openly with the community.**
    - The specification should not be used to produce proprietary or private data.
    - A catalog of tools and code libraries facilitates use of this specification (refer to Tools):
        - Tools support data sharing and conversion between open and proprietary formats.
        - Sample datasets provide examples of how to use the specification.
3. **The specification is designed to be as simple as possible yet provide the ability to capture precise detail when available. It aims to enable technical and nontechnical experts to effectively produce high-quality data.**
    - The specification defines four tiers of precision to facilitate broad adoption (refer to Tier Model).
        - Minimum requirements for creating and modifying data are a text editor and common web-based tools that can produce a GeoJSON file.
        - Geographic Information System (GIS) and enterprise asset-management tools can be used as well.
        - Users adopting the specification can increase their data precision over time if desired.

- The specification indicates specific required and recommended attributes for each tier of precision (refer to Metadata).
    - A minimum set of required attributes ensures attribute consistency and interoperability between datasets.
    - Recommended attributes allow users to provide more detailed data if desired.
    - New required attributes may be added through the specification-governance process.
- One canonical validator exists (URL TBD), and it is the authority on what data pass and do not pass the specification. This validator will fill out many of the metadata attributes with automatic or default values that users can edit.

4. **The specification prioritizes universal accessibility and the needs of all travelers across a range of use cases.**
    - The specification describes the infrastructure used for active-transportation travelers in urban, suburban, and rural contexts. For example, walking infrastructure may include sidewalks, shared-use paths, paved shoulders, low-volume roadways, etc.
    - The specification requires data producers to positive identify physical connections between various types of transportation infrastructure to enable routing and other use cases. For example, sidewalks on either side of an intersection, curb ramps, and crosswalks are all connected.
5. **The specification describes objective qualities of infrastructure.**
    - Specific measurements and objective terms are used instead of categorical values to ensure data users can make preference-based decisions related to routing and analysis.
        - The specification does not include subjective categorical values like “accessible / not accessible.”
        - Annotations for a sidewalk might include “width = 60 inches” and “maximum cross-slope = 2.1 percent.”
        - Annotation for a sidewalk, shared-use path, or other footway might include “surface material = asphalt.”
6. **The specification includes context that is useful for travelers and information systems.**

- This context, for data users, includes a metadata document with attributes for the data collection date, data collection methods, source data, relationships to other datasets, and data discoverability within catalogs and searches (refer to Metadata).

- The specification includes documented protocols for contributing and editing data in conformance with the specification.

7. **The specification is extensible and designed to be interoperable or interchangeable with other trusted specifications to make maintenance and creation as easy as possible.**

    - The specification can be extended by data creators as necessary to serve their needs, but minimum requirements must be met as indicated for each tier (refer to Tier Model).

    - Extensions may be considered for incorporation in future versions of the specification, subject to the established governance protocols.

1.4 Audience for This Document

The audience for this document includes anyone seeking to use GATIS to leverage active-transportation infrastructure data and/or improve the quality and usefulness of these data. Anticipated users include data producers and data consumers, such as the following:

- **Public agencies:**
    - USDOT and other federal agencies
    - State and local Departments of Transportation (DOTs)
    - State and local Departments of Public Works
    - State and local Departments of Planning and Community Development
    - Metropolitan and Regional Transportation Planning Organizations
    - Transit and paratransit agencies

- **Private entities:**
    - Data aggregators and vendors
    - Software developers
    - Transportation planning and engineering companies
    - Members of the public

- **Nongovernmental organizations:**
    - Academic and research institutions
    - Nonprofit and advocacy organizations

1.5 Anticipated Use Cases of This Specification

GATIS is designed to serve two use-case categories, Routing and Asset Management, with many anticipated subapplications. In line with existing governance processes, the specification may evolve to serve additional use cases with future revisions.

1.5.1 Routing

“Routing” means that different components of a network (edges or nodes that represent roads, paths, sidewalks, etc.) are linked together in the data such that users can calculate or model pathways through a network according to certain rules. For example, a person who prefers to follow a low-stress bicycle route may choose to travel along only separated bikeways and roads with low volumes and vehicle speeds, or a person with a mobility or visual impairment may wish to find routes that are suitable for wheelchair users or travelers using a cane.

Routing applications are typically used to model how well a network provides access to and from different parts of a region. One common application is modeling level of traffic stress (LTS) along network segments and at intersections. LTS can show how much of the network is suitable for bicycle riders or pedestrians with different preferences and what kinds of destinations they can reach. Routing can also help model connections to and from specific destinations, such as transit stations and mobility hubs; medical, civic, and education facilities; parks and open spaces; and other locations of interest to people traveling by active transportation.

Another application is modeling where people with different mobility preferences can travel unimpeded. This use case is important because any one impassable section of a route may require a detour or make it impossible for such users to complete their trip. Accurate data are critical to understanding where such conditions exist, especially if the modeling application is intended for user navigation. Navigation for people with visual, mobility, or other impairments requires detailed information about additional roadway features. Many of these features appear in the higher tiers of this specification.

In combination with demographic information, such as U.S. Census Bureau data, routing analysis can help users assess the distribution of active transportation across different populations, including access by specific populations to specific destinations (e.g., school-aged children’s walking access to elementary schools). In combination with Census, land-use, and motor vehicle data, active transportation–infrastructure data can support multimodal transportation modeling, allowing users to study the distribution of people and goods using multiple modes of transportation in addition to freight and passenger vehicles.

Each of these examples demonstrates how routing applications support gap analyses. Gap analyses help users identify locations to prioritize or avoid when routing or navigating. They also help public agencies determine where to plan and prioritize investment and which infrastructure improvements and traffic-operation changes to program for design and implementation.

1.5.2 Asset Management

Asset-management use cases require data on individual infrastructure elements. These data may include attributes like location, dimension, operational characteristics, and condition. For example, a user may wish to know the location of all curb ramps, the length of all bike lanes, or the condition of all sidewalks in a given area. Asset-management use cases are typically related to prioritizing maintenance, developing budget estimates, or measuring progress toward performance-measure goals.

Asset-management use cases often include programmatic-scale assessments of groups of infrastructure elements. Some applications may include simple inventories, such as the number of curb ramps that comply with Americans with Disabilities Act (ADA) requirements, the locations of all sidewalk extensions or median refuges, or the percentage of roadway crossings with adequate pedestrian lighting. Other applications include the evaluation of infrastructure condition, such as the surface quality of a shared-use paths, the visibility of bicycle-lane markings, or the legibility of signage.

In combination with other data, such as traffic crashes or vehicle speed and operations (e.g., hard braking), asset-management data for active-transportation infrastructure can help users study the relationship between infrastructure and safety. In combination with land-use and census data, these data can help users evaluate how well infrastructure is maintained and what elements exist in different parts of a community.

1.5.3 Use Case Conflicts

In rare cases, routing and asset management may have conflicting objectives. Asset management can be more flexible in representing active-transportation infrastructure than routing because routing requires explicitly defined connections between active-transportation infrastructure. For instance, tracking the locations of traffic-calming treatments, like curb-extensions or bulb outs, are straightforward to map as an asset but become more complicated to represent as a routable network feature. GATIS tries to anticipate possible conflicts, but certain active-transportation features simply may be more efficient to represent as nonroutable features.

1.6 Thank Yous

The following organizations and people were essential in the creation of this draft:

- The Co-Chairs of the National Collaboration on Bicycle, Pedestrian, and Accessibility Infrastructure Data (NC-BPAID):
    - Anat Caspi, Taskar Center for Accessible Technology, University of Washington
    - Bahar Datashova, Texas A&M Transportation Institute
    - Jeff Whitfield, Physical Activity and Health Branch, Centers for Disease Control and Prevention

- The Bureau of Transportation Statistics, U.S. Department of Transportation

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- Last but not least, the individuals and organizations who are currently reviewing this draft and helping to take it to the next level. We appreciate you!

2.0. Specification Overview

GATIS seeks to digitally represent bicycle, pedestrian, and accessibility infrastructure in the public right-of-way (shorthanded as active-transportation infrastructure throughout the rest of this document). Active-transportation infrastructure includes, but is not limited to, the following:

- Sidewalks
- Curb ramps
- Crosswalks
- Bicycle lanes
- Cycletracks
- Multi-use paths

To some extent, GATIS also seeks to digitally represent roads because cyclists are allowed to cycle on most roads, pedestrians are sometimes allowed to walk on roads, and knowing how active-transportation infrastructure interacts with the road is crucial for connectivity and safety analyses.

GATIS draws on the Public Right-of-Way Accessibility Guidelines (PROWAG), OpenSidewalks, OpenStreetMap, and discussions in the collaboration to create an extensive list of attributes with which users can precisely describe active-transportation infrastructure. Note that, while GATIS draws on OpenSidewalks and OpenStreetMap, the terminology used to describe active-transportation infrastructure has been modified to more closely reflect transportation engineering and planning practices in the United States and/or add clarity.

GATIS is designed to be extensible to other specifications, such as GTFS. This feature means GATIS allows for explicit linking to other specifications but forbids duplicating features. Practically speaking, this specification includes features that directly connect to a GTFS stop identifier (ID) but do not include features that could be represented in the GTFS dataset, such as station entrances, escalators, etc. The collaboration highly recommends the creators of extended datasets, like GTFS, complete all accessibility-related attributes. For GTFS, this recommendation means creating a complete Pathways dataset and completing attributes related to whether a transit car or stop allows boarding by wheelchair.

GATIS may not provide an exhaustive list of all possible methods for representing and describing active-transportation infrastructure, but the specification seeks to establish common practices and minimal requirements to help standardize the collection of these data and accomplish the overall goals of the specification.

2.1 Tier Model

Some data creators might be preparing active-transportation infrastructure datasets from scratch while others will be working with existing datasets that may (or may not) easily translate to this specification. The Tier Model aims to meet data creators where they are by providing a minimum set of requirements and a suggested roadmap for increasing the completeness, timeliness, precision, and other aspects of the data creators' existing bicycle and pedestrian data over time. The model also provides guidance on best practices for those creating new datasets.

The model's tiers are numbered from 1 to 4 in order of increasing value. The collaboration has not established a certification schema or recognition for achieving a particular tier. Rather, the model is meant to be self-guided. Tiers are intended to be mixed and matched across different aspects. An organization may be at Tier 2 when it comes to precision, for example, but at Tier 4 when it comes to completeness of the data. This system was inspired in part by the OpenStreetMap Pedestrian Working Group's proposed schema.

The Tier Model applies to:

- Which attributes are required for active-transportation infrastructure facilities (e.g., a sidewalk slope attribute is recommended at Tier 1 but required at Tier 2 and beyond)
- The routability of the prepared data
- How active-transportation infrastructure should be digitally represented
- How often data are updated

Throughout the remainder of this document, the Tier Model will be referenced whenever how a data creator can (or should) create data for the specification is a spectrum.

In summary, at lower or earlier tiers, the following are true:

- Data-collection processes are focused on creating an exhaustive inventory of assets that has a few attributes that may not be complete.
- Data in the specification's format are likely being used in conjunction with existing processes for use cases like project prioritization, but data are not likely routable or are routable within small islands.
- Geometry for active-transportation infrastructure may be connected to the road rather than being reflective of the real geometry of, for example, a sidewalk that runs alongside a road.

- Attribute values may not capture the complete variability in the field. For example, width may vary along the edge segment in the real world, while the data show constant values.
- Data are focused on one primary infrastructure type (e.g. bike paths *or* sidewalks).
- Linking to other datasets is possible but only spatially and inferentially. No shared identifiers exist across datasets.
- Data may only be partly vetted by the infrastructure owner or only vetted by third parties.
- Data are only a snapshot of any system of record. The data may be months old or more.

At later tiers, the following are true:

- Data-collection processes are focused on completeness of attributes for each asset.
- Data collectors likely received training and are using quality-assurance and quality-control processes that ensure minimal variance and maximum consistency across collectors. Collection technology may be highly accurate—for example, using light detection and ranging (LIDAR).
- Data are contained within a single-source-of-truth database across the organization, and established organizational processes mandate the use of this single source of truth across analysis, reporting, and other use cases, as well as derivative products.
- Data are routable via spatial attributes, metadata, and attributes that convey the needs of travelers with a range of mobility profiles.
- Geometries of active-transportation infrastructure are accurate, especially when they vary from the roadway. For example, a sidewalk adjacent to a road that deviates from the road to go around an obstruction is reflected in the data with distinct geometry.
- Edges are segmented when attribute values (such as width) change significantly.
- Complete, preference-based attributes on accessibility and the features of bicycle and pedestrian spaces are present in the data to enable modeling and routing based on traveler profiles.
- Alternative networks, which routing applications can optionally switch between, are provided. For example, bicycles can be routed between bike facilities, streets, multi-use paths, and other appropriate spaces.
- Linking to other datasets is enabled via identifiers stored within the data.
- Data are fully vetted by the infrastructure owner.

- APIs or other facilities exist to make edit suggestions to data when users discover errors.
- Data are recent and pulled directly from a system of record.

2.2 Concepts and Terminology Used in This Document

This section introduces the technical details and terminology of GATIS. This section is more general, while subsequent sections include more concrete details on how these terms and concepts apply to preparing specification data.

2.2.0 Core Geospatial Features

Core geospatial features are the geographically referenced and traversable representations that make up the GATIS network. In GATIS, core geospatial features can be categorized as one of three types: edges, nodes, and zones.

Edges, nodes, and zones should all represent active-transportation infrastructure that is part of the bicycle and pedestrian travel way. For pedestrians, a travel way includes infrastructure like sidewalks and crosswalks. For cyclists, a travel way includes dedicated cycling infrastructure like cycletracks and roads with bike lanes, but it may also include roads without bicycle infrastructure since cyclists are classified as vehicles and often expected to ride in the roadway.

In GATIS, each entity has a type and attached attributes that describe it (refer to Specification).

Table 1: Core geospatial entities in GATIS

Type	OGC Geospatial Format	Description	Examples
Edge	LineString	A segmented line that connects two nodes (points)	Sidewalks, roads, multi-use paths, cycletracks
Node	Point	A point that connects two or more edges (linestrings)	Generic node, curb ramps, impediments
Zone	Polygon	A closed segmented line that connects at least three nodes (points)	Pedestrian zone

At the first two tiers, data providers should prioritize capturing the physical infrastructure present to support more asset management–type use cases.

Over time, data providers should consider adding more preference-based attributes around accessibility and work to build a routable network (refer to Routing) that permits analysis of the infrastructure as a network.

2.2.1 Routing

The core geospatial entities should be represented as a network graph for routing. For the geospatial entities to be routable, entities should be topologically connected:

- Edges should have endpoint-to-endpoint connectivity (Figure 1).
- When two or more edges cross each other at-grade, they should all share a vertex or node at that intersection (Figure 2).

In addition to being topologically connected, a routable network can come with explicit network-referencing attributes, i.e. edges have two node-referencing attributes (“from_node_id” and “to_node_id”) that can be used to construct and identify directions in a network graph in addition to a unique edge ID.

When using network-referencing attributes, the edges in the network should be segmented such that every intersection (where two or more edges meet at-grade) results in a new edge (refer to Edge Segmentation).

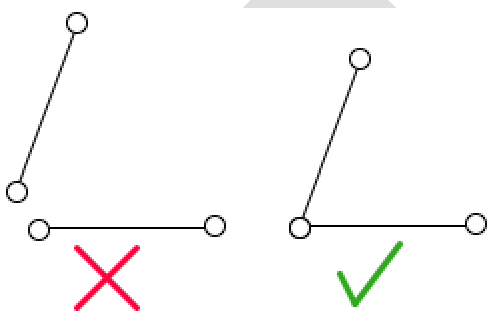

Figure 1: Endpoint-to-endpoint connectivity

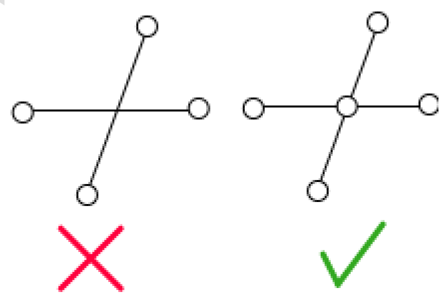

Figure 2: At-grade connectivity

GATIS strongly encourages creating routable networks to support detailed routing for cyclists and pedestrians. Routable networks create explicit relationships between edges that allow data users to utilize the data for comfort and accessibility analyses. When a crosswalk is explicitly connected to the road it crosses, then attributes of that road (like number of lanes crossed and whether there is a form of traffic control) can be attached to the crossing. When features are not routable, data users have to use geospatial processing to understand how features relate.

GATIS acknowledges that developing routable networks is a time-consuming process and that a nonroutable network can still support asset management. Generally, a topologically connected network would be required at Tier 3 and above. A network with networking referencing would be required at Tier 4. For new datasets, it is recommended that data be routable via graph metadata.

Table 2: Tier model

Data Aspect	Tier 1	Tier 2	Tier 3	Tier 4
Routable via Spatial Topology	Recommended; likely inconsistent across the dataset	--	Required; consistent within the dataset	--
Routable via Graph Metadata	Recommended, but encouraged	--	Recommended	Required
Conflation (i.e., linking to other networks)	Recommended; likely only spatially	Recommended; with ID values to a public dataset like OSM	--	Recommended; with ID values to a system of record

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Zones are polygon features that contain metadata that, similar to an edge, help routing applications determine how or when to route between nodes within the zone. Routing applications may determine how to model zones behind the scenes in their implementations. For example, they may choose to create pairwise edges between all nodes contained within the zone to effectively collapse zones into edges, or they may handle them at request time using another logic of their choice.

2.2.1 Directionality and the use of “left,” “right,” and “both”

Edges are directional; their direction is defined by either the sequence of vertices that make up the edge or the network reference IDs from the start node to the end node (if network reference IDs are included). Edge directionality indicates which general travel directions are permitted on an edge. This directionality has three values: forward, backward, and both.

Table 3: Directionality values

Allowed Travel Direction	Description	Example
Forward	Only forward travel is allowed from the first vertex to the last vertex.	One-way road, escalator
Backward	Only backward travel is allowed from the last vertex to the first vertex. This value is only used to indicate exceptions to the general direction of travel, such as contraflow bike lanes on one-way roads.	Contraflow bike lane on a one-way road
Both	Travel is allowed in both directions.	Sidewalks, stairs, two-way roads

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Certain attributes, such as "incline," are directional and depend on the direction traveled (uphill or downhill). These types of attributes should always be referenced to the edge's sequence of vertices to avoid confusion with the allowed directions.

As discussed in Recommended Practices for Digitizing Bicycle, Pedestrian and Accessibility Infrastructure Data, certain active-transportation infrastructure can be referenced in relation to a road. To accomplish this, three modifier attributes (**left**, **right**, and **both)** are used in conjunction with an edge's direction, establishing where these features are in relation to the road. For instance, a sidewalk on the left side of the road (in reference to the sequence of vertices) would be marked as "sidewalk:left:presence=yes." Similar to incline, the information would be different when going the opposite direction on the link (i.e., now the sidewalk would be on the right side).

2.2.2 Edge Segmentation

"Edge segmentation" refers to how edges are divided into parts in the dataset. GATIS does not include specific recommendations on network segmentation, but note, each edge can only support one set of attributes along its entire length. Practically speaking, this requirement means that modeling a change in sidewalk width, for example, requires creating two edges with the two different width values. Data creators working with a linear referencing system (LRS) dataset or a General Modeling Network Specification (GMNS) dataset with segment data on their links need to segment out their data to conform to GATIS since these formats support attaching multiple sets of attributes to one geospatial feature. When providing a routable network, edges should be segmented at intersections as well.

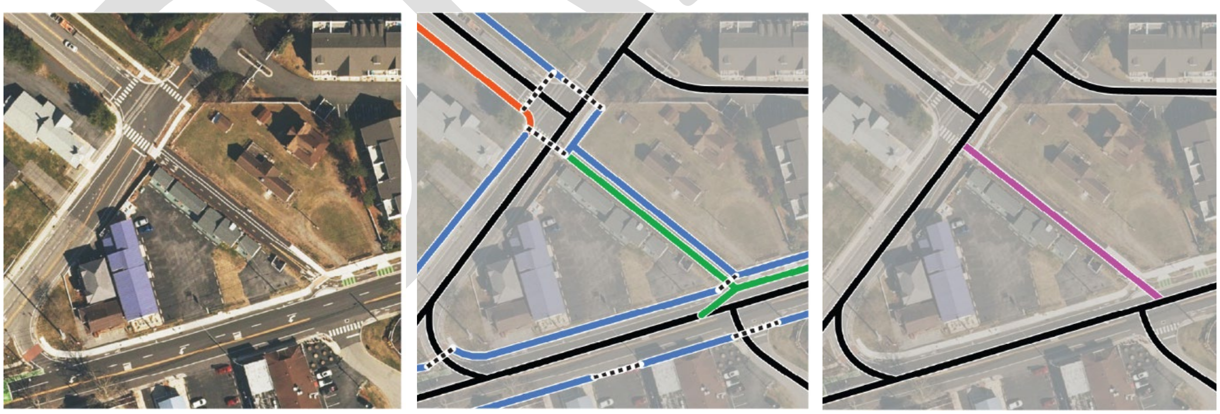
Important: Note that the segmentation of an edge in the data does not necessarily have to reflect the segmentation of the geometry—for example, an “S”-shaped path that is consistent in width may only have one edge in the data, yet may be segmented multiple times geometrically to form its “S” shape.

2.3 Recommended Practices for Digitizing Bicycle, Pedestrian, and Accessibility Infrastructure

Several conventions for digitizing active-transportation infrastructure spatial data have emerged over the last two decades. Refer to https://github.com/dotbts/BPA/tree/main/resources/attribute_tracker for an extensive list of existing active-transportation infrastructure datasets.

Because many bicycle facilities, shared-use paths and multi-use paths, and sidewalks are built along, within, or around roadways (roadway aligned), one of the most common differences in representing active-transportation infrastructure geospatially is whether these facilities are modeled as attributes on the roadway centerline or as separate geospatial features with their own dedicated attributes.

Figure 3 shows schematics depicting this difference. Figure 3a shows the existing conditions. Figure 3b shows what is referred to as “Network Representation.” It models sidewalks and crosswalks as their own separate centerlines. It models bicycle facilities that are physically separated from the road as separate centerlines, while keeping bicycle facilities that are integrated in the road (for example, separated by paint, refer to Section 2.3.1.0) represented as attributes on a road centerline. Figure 3c shows what is referred to as “Roadway Centerline Representation**.”** This image models sidewalks and all bicycle facilities as part of the road centerline except for one multi-use path that is separate from the roadway.



a) b) c)

Figure 3 a) aerial photo of streets, sidewalks, and bicycle paths b) network representation c) roadway centerline representation

While GATIS allows for both methods of representation, it advocates for data creators to move toward network representation for sidewalks, multi-use pathways, and some types of bicycle facilities (described in Exceptions to Network Representation) to facilitate more precision in describing the infrastructure and accomplishing the intended use cases of routing and asset management. Network representation also allows for better spatial description and flagging of obstructions or impediments to accessible travel.

The next sections will provide general guidance on roadway centerline representation and network representation.

2.3.0 Roadway Centerline Representation

Roadway-centerline representation is a method of representing the presence and physical description of roadway-aligned bikeways, sidewalks, and other pathways using attributes on a roadway centerline. Sidewalks and bike lanes are not always symmetrical along a road; a sidewalk may exist on only one side of the road but not the other side. Roadway-centerline representation tracks both sides independently using the “left,” “right,” and “both” attribute modifiers (refer to Routing). Left and right are always used in reference to the sequence of vertices that make up the edge (from beginning to end). Figure 4 demonstrates how the presence of sidewalks and shared-use paths on the left and right side of the roadway are tracked while Figure 5 demonstrates how the presence of bike lanes and shared-use path on the left and right side of the roadway are tracked.

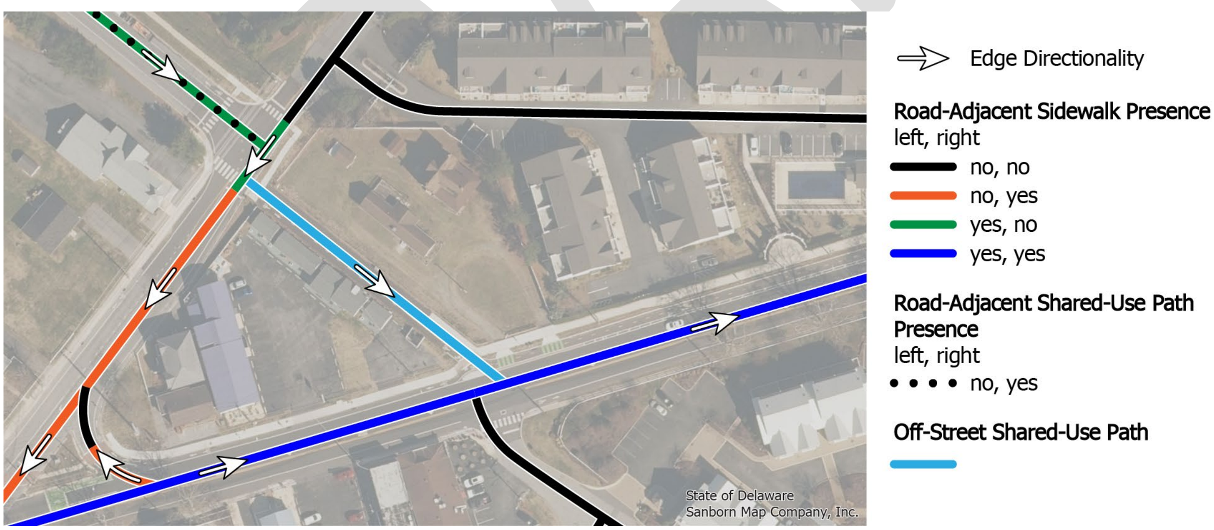


Figure 4: Road centerline representation of sidewalks

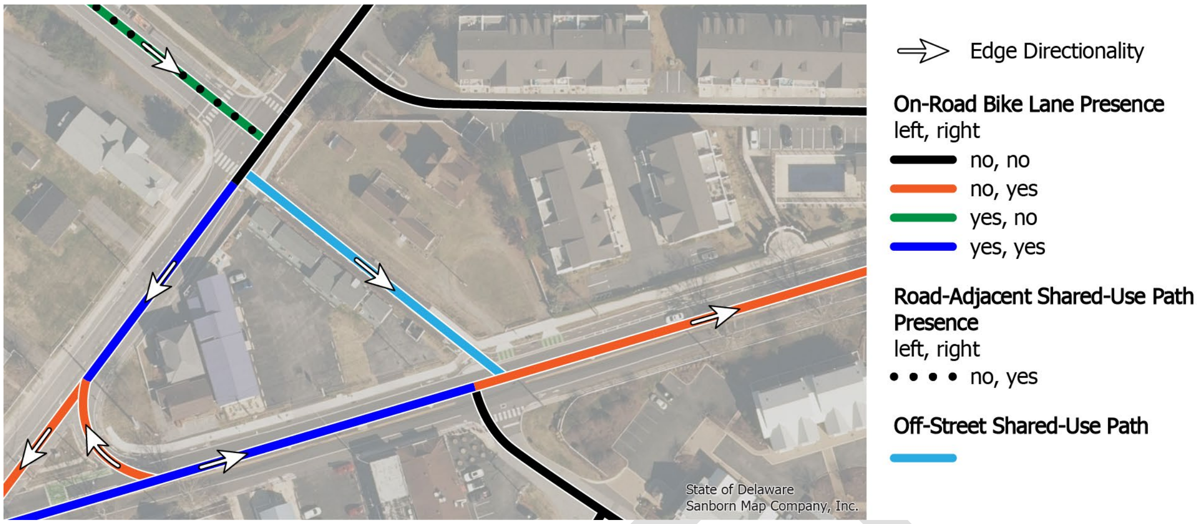


Figure 5: Road centerline representation of bike lanes

In roadway-centerline representation, roadway-aligned active-transportation infrastructure does not have its own spatial representation or separate geometric features. This limitation reduces spatial precision and the ability to provide active-transportation users with precise and customized routing.

2.3.1 Network Representation

Network representation provides a more comprehensive and detailed spatial description of bikeways, sidewalks, pathways, etc. Network representation also allows for geospatial representation of roadway crossings at crosswalks as edges. Figure 6 shows an example of network representation. In network representation, bike lanes are still represented on the road centerline (refer to Exceptions to Network Representation).

Network representation has some drawbacks. Representing network features separately removes the explicit association between them, and the added geometric complexity may also complicate geospatial operations, map matching, or routing efforts. Additionally, some active-transportation infrastructure features, such as bike lanes, should not get their own dedicated feature.

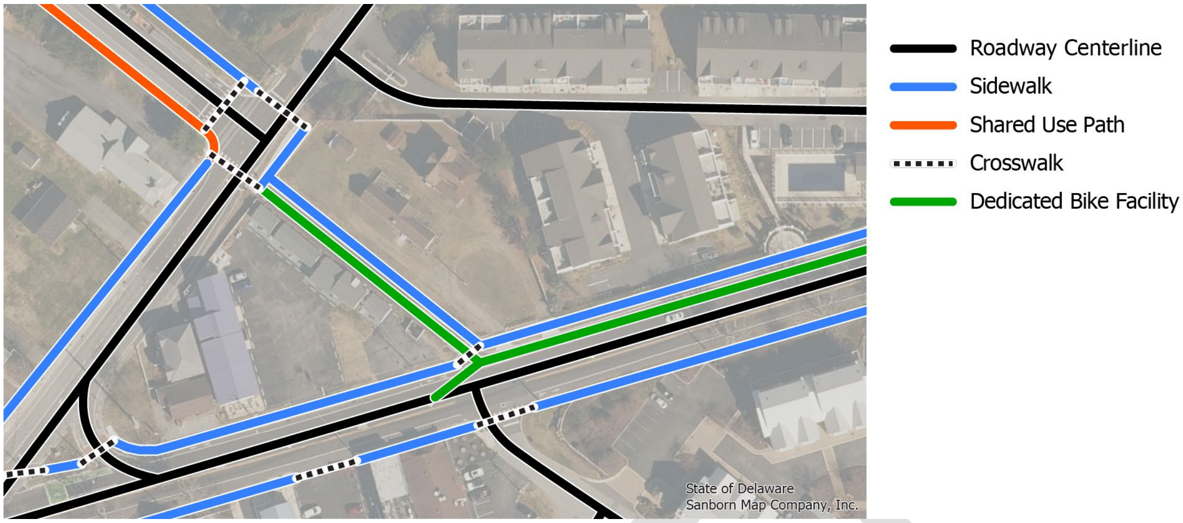


Figure 6: Network representation of sidewalks and dedicated bike facilities

2.3.1.0 Exceptions to Network Representation

For active-transportation infrastructure that is along, within, or around a road (roadway aligned), there are a few instances in which it is not recommended to represent the active-transportation infrastructure as a separate spatial feature from the road centerline. The rule of thumb for deciding whether to draw a feature as a separate centerline (instead of representing it with attributes on the road) is to ask the following questions:

1) Is the active-transportation infrastructure integrated into the road?
    a) Is the path taken on active-transportation infrastructure distinct from the path taken on the road centerline?
    b) Are cars prevented from entering and/or crossing into the active-transportation infrastructure?
    c) Does an obstacle (physical or legal) prevent transitioning between the road and the active-transportation infrastructure? For example, a curb, a continuous concrete barrier, etc.
2) Does the active-transportation infrastructure have attributes that would be too complicated to track on the road centerline?

For instance, (1) sidewalks are usually not integrated into the road because (a) sidewalks often meander, deviate, or depart from the road, (b) cars cannot easily access sidewalks, and (c) sidewalks are typically separated from the road with a curb or a grass strip. It is also (2) really complicated to track sidewalk attributes like running slope, cross slope, surface type, condition, etc., on the road centerline.

The one type of active-transportation infrastructure facility that should be represented as an attribute on the road are bicycle facilities that are painted on the road with no accompanying separation. These are (1) integrated with the road because (a) they take the same path as the road (b) there is no meaningful obstacle (physical or legal) between the active-transportation infrastructure and the road (c) it is not complicated to track the attributes of these bicycle facilities on the roadway centerline.

Exceptions to the rule for painted bike lanes include the following:

- Segments of protected bike facilities that are paint protected
- Bike crossings at protected intersections

3.0 Specification

This section walks through the specifics of data structured under the GATIS specification. It starts by describing the file structure, which lays out the different types of geospatial features within the data, each of which appears in its own file. It then defines some key terms, describes how to know which attributes are required and recommended, and outlines the attribute data types used within the specifications. The rest of the section conveys the details to begin structuring data using the specification.

3.1 Files

All files must be in GeoJSON or JSON format with attributes as feature properties.

The files that make up the specification are as follows:

- Metadata File
  - JSON
- Nodes File
  - Named as “nodes.geojson”
  - GeoJSON features must be POINT type
- Edges File
  - Named as “edges.geojson”
  - GeoJSON features must be LINE type (MULTILINE type is not supported)
- Points File
  - Named as “points.geojson”
  - GeoJSON features must be POINT type
- Zones File
  - Named as “zones.geojson”
  - GeoJSON features must be POLYGON type (MULTIPOLYGON type is not supported)

3.2 Definitions

- **Attribute**—An attribute is a field or value that provides deeper information about a feature. For example, the attribute “width” describes how wide a piece of infrastructure (like a bike lane or a curb ramp) is.
- **Edge**—An edge is a geospatial line that represents the path of travel between two nodes in a routable network or graph. Within this specification, edges represent the centerlines of different pieces of linear-shaped infrastructure, such as sidewalks, bike lanes, and crossings.
- **Edge cost or impedance**—Within a routable network or graph, edges can be assigned costs or values based on how they may impact a traveler. These costs can be based on a range of attributes, such as length (or distance traveled), travel time or exposure to

vehicle traffic. A router would use an edge cost to find the route or routes that best satisfy the needs of an individual traveler.

- **Metadata-based graph inference**—A metadata-based graph inference is using attributes about features to draw conclusions about their connectivity or the relationship between them. For example, an analyst may use “to_node” and “from_node” attributes to determine that a traveler can connect from one edge to another because both edges are connected by the same node.
- **Network features**—These features include any bicycle and/or pedestrian way. Network features can define a routable network or graph. Network features can also represent a physical impediment (like an obstruction) or routing restrictions (like a closure).
- **Node**—A node is a geospatial point that represents the connection between two or more edges in a routable network or graph. Within this specification, nodes most often indicate a particular type of infrastructure, such as a curb ramp or a transit stop.
- **Non-network features**—These features include any data that are not physically located on a bicycle or pedestrian way but might be important for travelers to know about. Examples include street furniture, parklets, and drinking fountains.
- **Routable network or graph**—A routable network or graph is a representation of relationships between features that is defined by nodes and edges. When these nodes and edges are connected correctly, a router can use the network or graph to map out a travel path for a bicyclist or pedestrian. Refer to Routing for a deeper explanation of what makes a network routable.
- **Router**—A router is a type of software designed to make calculations from a routable network or graph and return a suggested route between the origin of a trip and the destination. Routers can be designed to return routes based on a range of criteria. For example, they can recommend and prioritize multiple routes, take information about specific travelers and attempt to optimize routes based on traveler needs, and optimize route choices based on factors such as faster travel time, shorter distance or reduced exposure to vehicle traffic. Routers are typically third-party software that take data created using these specifications as an input.
- **Spatial (graph) inference**—A spatial inference is using the geospatial coordinate data about two or more features to draw conclusions about their connectivity or the relationship between them. Within a routable network or graph, if a node and an edge touch or are close to each other, spatial inference can be used to conclude that the features they represent are physically connected.
- **Zone**—A zone is a geospatial polygon that represents a defined area. Within this specification, zones are used to indicate areas, such as parks and plazas, where pedestrians may choose their path freely within the polygon space.

3.3 Presence Descriptors Used In This Specification

A presence descriptor is a term used to describe whether an attribute should be included in a dataset. The following presence descriptors are used in GATIS:

- **Recommended**—The attribute may be omitted from the dataset, but the specification encourages that it be included.
- **Required**—The attribute must be included in the dataset and contain a valid value for each record.
- **Conditionally Required**—The attribute must be included under conditions outlined in the attribute description.
- **Conditionally Forbidden**—The attribute must not be included under conditions outlined in the attribute or file description.
- **Optional**—Attributes that are recommended or required at higher tiers are automatically optional at lower tiers. Optional attributes can be included but should not be considered a priority.

NOTE: The presence of attributes changes across tiers.

3.4 Attribute Types Used In This Specification

- **Array<Type>**—An array is an ordered collection of values, structured according to JSON. All of the values within an array must be of the same data type, such as boolean, float or text. In the specification, this data type will be specified for each array.
- **Boolean**—A boolean value can take one of two possible values: “yes” or “no,”
- **Date**—The dates within this specification use the ISO 8601 format. In most cases, dates should be as granular as possible, ideally containing the year, month, and day.
  Example: `2018-09-13` *for September 13th, 2018.*
- **Datetime**—Datetimes also use the ISO 8601 format. A datetime should contain the year, month, day, hour, minute, and second. Use 24-hour two-digit codes for hours. If lower values are not available, zeros may substitute.
  Example: `2018-09-13T13:23:14` *for September 13th, 2018 at 1:23:14 pm.*
- **Enum**—An enum is a set of predefined values, from which one value must be chosen and any values outside of the set are not valid. “Categorical” is another word for enum. The possible values for each enum will all be of the same type, such as text or integer.
  Example: `The directionality attribute can be forward, backward, both.`
- **Float**—A float represents a real number that has a decimal value, or is not a whole number.
  Example: 4.12.
- **ID**—An ID attribute is used to store unique values identifying each individual example of a particular type of thing, such as each bike lane segment or each curb cut. IDs should be as stable over time as possible. IDs are meant to be referenced across the .txt files that make up the specification and can be used for blending data with other data sources.

- **Integer**—An integer is a whole number, with no decimal values.
  Example: 4.
- **Text**—A text value is a string of UTF-8 characters, representing either a human readable value (such as a word) or a set of mixed characters that cannot be represented in another way (such as a string containing letters, numbers and punctuation marks). Within this specification, some text attributes have recommended string values but allow for analysts to add other values as well to increase standardization without being overly restrictive.
- **URL**—A URL is a set of characters identifying the location of a site on the internet. Within this specification, URLs should be fully qualified. They should include http:// or https:// at the start, and any special characters in the URL must be correctly escaped.

All geospatial features, listed out in Core Geospatial Features, use the Open Geospatial Consortium (OGC) Format.

3.5 Metadata

This section describes the file-level metadata elements for the metadata.txt file. Note that file-level metadata describe the dataset as a whole. Some attributes within this schema provide metadata about features (such as the “node_to” and “node_from” attributes for edges) that appear elsewhere in GATIS.

This metadata schema shares some attributes and commonalities with the following schemas:

- Data Catalog Application Profile for the USA (DCAT)
- Croissant Format Specification
- The Data Cards Playbook
- The Data Nutrition Project
- OpenSidewalks Data Schema

The validator will help to populate the following attributes: schema_version, date_created (using current datetime), license (using Creative Commons Universal license URL), geographic_bounding_box, keywords (default values), attribution (concatenation of Title, Publisher, Version, Data Download URL, and License), date_modified (using current datetime), and checksum (generation of MD5 hash). It can also help populate the conforms_to attribute by inserting URLs for specifications selected from a prepopulated list by the user.

Attribute Name	Type	Description	Status	Tier	Metadata Type
title	Text	The title of the dataset	Required	1, 2, 3, 4	Basic
version	Text	Version number for the current dataset using [semantic versioning](). Format: MAJOR.MINOR.PATCH	Required	2, 3, 4	Basic
description	Text	A brief (1–2 sentence or similar) description of what's in the dataset	Required	1, 2, 3, 4	Basic
publisher	Text	Organization responsible for collecting and maintaining the data	Required	1, 2, 3, 4	Basic
schema_version	Text	The version of the NC-BPAID schema in use; use current version here as default value	Required	1, 2, 3, 4	Basic

Attribute Name	Type	Description	Status	Tier	Metadata Type
date_created	Datetime	The date when this dataset was initially created	Required	1, 2, 3, 4	Basic
contact_name	Text	The name of a person who can be contacted with questions or for further information about the data	Recommended	1, 2, 3, 4	Basic
contact_info	Text	The email address or phone number to reach someone who can answer questions or provide further information about the data	Required	1, 2, 3, 4	Basic

Attribute Name	Type	Description	Status	Tier	Metadata Type
license	URL	The license under which the data are published for use; URL linking to the license agreement; default value https://creativecommons.org/publicdomain/zero/1.0/	Required	1, 2, 3, 4	Basic
geo_bounding_box	Polygon or MultiPolygon	Geospatial data describing the upper and lower latitudes and longitudes within which the data fall	Recommended	1, 2, 3, 4	Basic
keywords	Text	A set of single words or short phrases that describe the content of the data	Required	1, 2, 3, 4	Basic

Attribute Name	**Type**	**Description**	**Status**	**Tier**	**Metadata Type**
attribution	Text	Line of text that a data user can copy to properly cite the dataset; TASL format (Title, Author, Source, License) or academic format (ALA, Chicago) recommended	Recommended	2, 3, 4	Detailed
data_download_url	Text	Direct URL to begin downloading the data; should not require additional clicks or steps besides visiting the URL to begin download	Recommended	2, 3, 4	Detailed
data_docs_url	Text	URL to access a data documentation booklet or site covering methodologies and other technical aspects of the data	Recommended	2, 3, 4	Detailed

Attribute Name	Type	Description	Status	Tier	Metadata Type
data_dictionary_url	Text	URL to access the data dictionary for the dataset, in PDF, HTML, or JSON format	Recommended	2, 3, 4	Detailed
data_service_endpoint_url	Text	URL to access the data via a data service, such as Data.gov (catalog.data.gov/dataset/…), ArcGIS Online (ex. Feature service or feature layer link) or Socrata	Recommended	2, 3, 4	Detailed

Attribute Name	Type	Description	Status	Tier	Metadata Type
rights_usage_limits_restricts	Text or URL	Text or a URL providing greater detail on how the data can and should be used, what rights are reserved, the scope of the data and any other useful information. Populate with either a text statement or with a URL linking to a text statement or policy	Recommended	2, 3, 4	Detailed
quality_validation	Text or URL	Statement describing the methods used to ensure quality and to validate the data, providing quantitative results where possible; can be a link to a web page or tool containing more information	Recommended	2, 3, 4	Detailed

Attribute Name	Type	Description	Status	Tier	Metadata Type
date_modified	Datetime	The date when this dataset was last updated	Required if updates have occurred	3, 4	Data Collection & Maintenance
checksum	Text	An MD5 sum associated with the dataset in its current state, used to check if the data has changed since last accessed; new checksums should be generated each time the data are updated	Recommended	3, 4	Data Collection & Maintenance

Attribute Name	Type	Description	Status	Tier	Metadata Type
freq_cadence	Enum	How often the full data are updated—for example, when new LIDAR is collected or a new field study is conducted; do not use for minor updates (ex. Correcting a few rows); Use values from the Dublin Core frequency specification	Recommended	3, 4	Data Collection & Maintenance
modification_notes	Text	Text statement describing recent updates or modifications that regular users might want to know about.	Recommended	3, 4	Data Collection & Maintenance

Attribute Name	Type	Description	Status	Tier	Metadata Type
collection_period_start	Date	Beginning date of the period during which data was collected; approximation is acceptable. Include at least the month and the year if possible.	Recommended; if frequency / cadence = ‘continuous,’ leave blank	3, 4	Data Collection & Maintenance
collection_period_end	Date	Ending date of the period during which data was collected; approximation is acceptable. Include at least the month and the year if possible.	Recommended; if frequency / cadence = ‘continuous,’ leave blank	3, 4	Data Collection & Maintenance

Attribute Name	Type	Description	Status	Tier	Metadata Type
collection_method	Array (enum)	List of the methods used to collect and extract the data. Values: Satellite / aerial; LIDAR; field survey / manual; GPS survey; hand traced or tagged; AI interpretation; transformation from another format / database	Recommended	3, 4	Data Collection & Maintenance
collection_notes	Text	Text statement providing additional detail about data collection methods and approach, including selection, tools and data processing.	Recommended	3, 4	Data Collection & Maintenance

Attribute Name	Type	Description	Status	Tier	Metadata Type
conforms_to	Array (URL)	List of the URLs of other specifications to which attributes within the data also conform.	Recommended	3, 4	Provenance & Relationships
source_dataset	Text	Either a link or a citation (title, publisher and publication date) to the primary dataset used to create the data; in many cases, this data will be satellite or LIDAR data used for extracting transportation elements.	Recommended	3, 4	Provenance & Relationships

Attribute Name	Type	Description	Status	Tier	Metadata Type
source_dataset_type	Enum	The type of dataset listed under Primary Source Dataset URL or Citation. Values: aerial / satellite, LIDAR, GPS, field / manual, other	Recommended	4	Provenance & Relationships
addl_sources	Text	List of URLs or citations for additional data sources used besides the primary data source—i.e., for blending, for extracting additional features, etc.	Recommended	4	Provenance & Relationships
source_notes	Text	Text note describing any additional information about data sources, including how they were collected, any known issues and cleaning and processing.	Recommended	4	Provenance & Relationships

Attribute Name	Type	Description	Status	Tier	Metadata Type
contributor_consulted	Text	Text statement acknowledging people or organizations who contributed or who were consulted in creation of the dataset.	Recommended	4	Provenance & Relationships
used_by	Text	Text statement describing related datasets or projects—for example, if another organization takes this data and layers on additional features. Include URLs where possible.	Recommended	4	Provenance & Relationships
funding_organization	Text	Name of the organization(s) who provided funding to enable any part of the effort to produce the dataset.	Recommended	4	Provenance & Relationships

3.6 Nodes

3.6.0 Node Types

This table lists all the allowed node types in GATIS.

Name	Description	Tier
virtual	Used to create nodes for routing in places where specific physical infrastructure doesn't exist, where edges are split because attributes are different between them, or where other nodes don't suit the purpose. Nodes are required between edges to build a routable network.	3
curb_ramp	Indicates a location where a pedestrian must make a decision about which direction to travel, most commonly in locations where a curb ramp does or should exist. Curbs are nodes, connected to the graph network. Where double ramps or other configurations exist, map each ramp as its own curb_ramp node with its own attributes.	1
ramp	Indicates any type of ramp besides a curb ramp, where the footpath is built to deliberately slope up or down to improve access.	2
elevator	Elevators, funiculars or other car- or enclosure-based constructions meant to vertically carry a pedestrian from one level of physical infrastructure to another. NC-BPAID maps outdoor infrastructure; switch to GTFS Pathways or IMDF conventions for indoor infrastructure.	3
transit_stop	A node indicating the location of a transit stop of any kind.	3
issue	A node indicating a particular point that has an issue relevant to routing for some travelers. Issue nodes mark points along an edge that may be of concern; other node types (such as ramps and signals) have their own issue attributes.	3
traffic_calming	A node indicating a particular point that has an issue relevant to routing for some travelers. Issue nodes mark points along an edge that may be of concern; other node types (such as ramps and signals) have their own issue attributes.	3

3.6.1 Recommended and Required Attributes for Nodes

This table gives an overview of the recommended and required attributes for nodes based on the type of node.

Node Type	Tier	Required	Recommended
virtual	Tier 1	--	--
	Tier 2	--	--
	Tier 3	node_id, node_type	curb_type, rail_crossing
	Tier 4	node_id, node_type	curb_type, rail_crossing
curb_ramp	Tier 1	node_id, node_type	--
	Tier 2	node_id, node_type	date_built, check_date, ada_compliance, status

	Tier 3	node_id, node_type, incline, cross_slope, width, detectable_warning, status	date_built, check_date, ada_compliance, ramp_type, impediment, surface_issue
	Tier 4	node_id, node_type, incline, cross_slope, width, detectable_warning, impediment, surface_issue, status	date_built, check_date, ada_compliance, ramp_type
ramp	Tier 1	--	--
	Tier 2	node_id, node_type	ada_compliance
	Tier 3	node_id, node_type, incline, cross_slope, width, detectable_warning	date_built, check_date, ada_compliance, impediment, surface_issue, status
	Tier 4	node_id, node_type, incline, cross_slope, width, detectable_warning, impediment, surface_issue, status	date_built, check_date, ada_compliance
elevator	Tier 1	--	--
	Tier 2	--	--
	Tier 3	node_id, node_type	date_built, check_date, ada_compliance, status
	Tier 4	node_id, node_type, status	date_built, check_date, ada_compliance
transit_stop	Tier 1	--	--
	Tier 2	--	--
	Tier 3	--	stop_id, stop_code
	Tier 4	--	stop_id, stop_code
issue	Tier 1	--	--
	Tier 2	--	--
	Tier 3	node_id, node_type	check_date, impediment, surface_issue
	Tier 4	node_id, node_type, impediment, surface_issue	check_date
traffic_calming	Tier 1	--	--
	Tier 2	--	--
	Tier 3	node_id, node_type	date_built, check_date, traffic_calming_type
	Tier 4	node_id, node_type, traffic_calming_type	date_built, check_date

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3.6.2 Node Attributes

The following table lists all the node attributes.

Name	Type	Description
node_id	ID	A unique identifier for the node. [NOTE: We will fill in instructions here on how to generate IDs, and we will also provide a data validator that may be capable of validating and helping to fill in these IDs.]
node_type	Enum	Indicates the type of node. Valid Options: virtual curb_ramp ramp elevator transit_stop issue traffic_calming
presence	Enum	Indicates whether the piece of infrastructure exists or is present. When other attributes are provided, the existence of the infrastructure can be assumed. This attribute is useful for identifying where a curb ramp or other infrastructure might be missing or where its presence is unknown. Conditionally required if no other identifying attributes provided. Valid Options: yes no missing unknown
date_built	Date	When the facility was officially opened for use. If the facility has had a major remodeling where the structure, shape or another fundamental aspect was changed, the date of remodeling can be placed here. In ISO 8601 format containing the month and year or just year if month is not available.
check_date	Date	The date that this infrastructure was last inspected. Report the month and year or just year if month is not available.
curb_type	Enum	The type of curb that is present, if there is not a curb ramp.

		Valid Options: raised rolled flush generic driveway other
ada_compliance	Enum	States whether the piece of infrastructure was considered to be ADA compliant the last time it was officially assessed. This attribute should come from formal assessments and not be created using other available data (ex. Width, cross slope, etc.), since compliance status is based on many detailed, interacting factors. If ada_compliance is filled out, ada_compliance_date and ada_compliance_standard should also be filled out. Valid Options: yes no unknown
ada_compliance_date	Date	Indicates the date when ADA compliance was assessed. Report in ISO 8601 format containing month and year, or just year if month is not available. This field is conditionally required if "ada_compliance" is filled out.
ada_compliance_standard	Enum	The specific ADA guidelines or standards used in the assessment of this infrastructure. This field is conditionally required if "ada_compliance_standard" is filled out. Valid Options: 2010 PROWAG other
incline	Float	Indicates the incline or running slope of the ramp, following the possible directions of travel. Reported as a decimal number describing the percentage of the slope, with two points of precision. Example: 0.0325
cross_slope	Float	Indicates the cross slope of the ramp, which runs perpendicular to the incline / directions of travel. Reported as a decimal number describing the percentage of the slope, with two points of precision. Cannot be negative. Example: 0.0325
width	Float	Indicates the minimum width of the ramp, measured between the handrails if handrails are provided. Reported as a whole number rounded to the nearest inch.
ramp_type	Text	Indicates the orientation of the ramp in relation to the pedestrian direction of travel at the location. Where a double curb ramp exists, map each ramp as a separate curb_ramp

		node. Recommended Options: diagonal parallel perpendicular unknown
detectable_warning	Enum	Describes whether tactile paving is present, and whether or not it has a constrasting color (which should meet ADA guidelines for the amount of contrast). Valid Options: tactile and contrasted tactile and not contrasted not tactile and contrasted no
impediment	Array<Enum>	Identifies the type of object that may pose a challenge for travelers passing through the area. Mark an issue with a node only if it is close enough to the footpath or pedestrian way to potentially pose a challenge. “Horizontal overgrowth” refers to temporary obstruction at ground level, such as bushes or plants. “Vertical overgrowth” refers to temporary obstruction between 25-80" high, such as a branch or limb. “Fixed vertical obstruction” refers to a permanent obstruction between 25-80" high, such as a sign. “Solid fixed object” includes street furniture, planters and other objects that cannot be difficult to navigate around and are within the pedestrian way. “Flexible fixed object” refers to bollards and other objects that some travelers may be able to navigate around and that are within the pedestrian way. “Protrusion” refers to objects of any type that are primarily located out of the pedestrian way but have some portion of them that sticks out into the pedestrian space. Valid Options: yes, no, horizontal overgrowth, vertical overgrowth, fixed vertical obstruction, solid fixed object, flexible fixed object, protrusion, turning space missing or issue, detectable warning not aligned with crossing, push button not working, other
surface_issue	Array<Enum>	Identifies the type of damage or surface quality issue that may pose a challenge for travelers. Valid Options: Cracking, scaling, spalling, uneven / displacement, frequent water pooling, heaving, missing bricks / stones, grates / utility covers / other surface impediments, potholes / holes, slickness, uneven joints, markings worn / missing, detectable warning surface damage, other
rail_crossing	Array<Enum>	Describes the pedestrian traffic warnings and controls in the approach to the rail crossing. The nodes mark the location of the controls on each side of the tracks. Mark the crossing itself as a virtual link (edge).

		Valid Options: Gates and flashing lights, flashing lights only, crossbucks or stop sign only, tactile markings, other
stop_id	Integer	The numeric stop_id from GTFS for this transit stop. These IDs can be crosswalked with GTFS and TIDES data to obtain additional stop attributes. May choose between using stop_id and stop_code to identify stops; see the GTFS documentation for more information. agency_id is conditionally required if stop_id is filled out.
agency_id	Integer	The numeric agency_id from GTFS for the agency that manages this transit stop. Because stop_ids and stop_codes are not unique across agencies within GTFS and TIDES, agency_id must be used in order to uniquely identify stops. Conditionally required if stop_id or stop_code is filled out.
traffic_calming_type	Enum	Used to identify traffic calming features on a road or crossing. Used when it makes more sense to model the traffic calming feature as a node instead of an edge. Recommended values are from https://www.ite.org/pub/?id=2a60c136-b1c0-b231-0522-ccbd075cac84 and https://wiki.openstreetmap.org/wiki/Key:traffic_calming Valid Options: chicane, choker, closer, diagonal diverter, lateral shift, median barrier/forced turn island, median island, mini roundabout, raised intersection, realigned intersection, road diet, roundabout

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3.7 Edges

3.7.0 Edge Types

This table lists all the allowed edge types in GATIS.

Name	Description	Tier
road	A public road primarily intended for automobile travel. Sidewalk and bikeway edges can be represented as part of a road edge using the left/right/both modifiers. See the Specification Document for more information.	1
sidewalk	A designated pedestrian path along the side of a roadway. This edge type includes pedestrian lanes, in which a section of the roadway surface is divided out for pedestrian use; use pedestrian_lane attribute to indicate. Can use the left/right/both field modifiers to represent this edge type on a road edge.	1
footpath	A dedicated pedestrian path that does not fall into another category. Primarily used for connecting sidewalks to crossings.	2
crossing	A location where infrastructure or a designation exists to help pedestrians and/or cyclists cross traffic lanes or other areas designated for traffic. In many locations, a crossing is a crosswalk.	1
traffic_island	A median or other raised or protected area between traffic lanes on the road surface meant to provide a safe space for pedestrians to stop. A traffic island may or may not have a midblock entrance. Can be used to indicate transit islands.	2
steps	Fixed steps or stairs that appear along a pedestrian way. NC-BPAID maps outdoor infrastructure; switch to GTFS Pathways or IMDF conventions for indoor infrastructure.	3
escalator	Escalators or any other construction of moving stairs meant to carry a pedestrian from one level of physical infrastructure to another. NC-BPAID maps outdoor infrastructure; switch to GTFS Pathways or IMDF conventions for indoor infrastructure.	3
bikeway	A designated cycling lane or path that can be on, next to or away from a road. If pedestrian usage is designated then use multi_use_path edge type instead. Can use the left/right/both modifiers to represent this edge type on a road edge.	1
multi_use_path	A generic link that allows both bike and pedestrian travel. It can take on both sidewalk and cycleway attributes.	2
trail	Any kind of path or trail that allows bicycle or pedestrian travel that wouldn't fall into the multi_use_path designation. Includes official and unofficial unpaved trails, social trails, goatpaths and desire lines.	2

virtual_link	Links added for topology, connectivity, or crossing reasons by the analyst. Does not relate to a piece of physical infrastructure in the real world.	2

3.7.1 Recommended and Required Attributes for Edges

These tables give an overview of the recommended and required attributes for edges based on the type of edge.

Edge Type	Tier	Required	Recommended
road	Tier 1	edge_id, street_name, edge_type	--
	Tier 2	edge_id, street_name, edge_type, from_node, to_node, surface_material, incline	traffic_volume, posted_speed_limit, car_freeflow_speed, thru_lanes, aux_lanes, shoulder_width, roadway_centerline, bridge
	Tier 3	edge_id, street_name, edge_type, from_node, to_node, bridge, surface_material, incline	traffic_volume, posted_speed_limit, car_freeflow_speed, thru_lanes, aux_lanes, shoulder_width, roadway_centerline, traffic_calming, curb_height
	Tier 4	edge_id, street_name, edge_type, from_node, to_node, bridge, surface_material, incline	traffic_volume, posted_speed_limit, car_freeflow_speed, thru_lanes, aux_lanes, shoulder_width, roadway_centerline, traffic_calming, curb_height
sidewalk	Tier 1	edge_id, edge_type	--
	Tier 2	edge_id, street_name, edge_type, width, surface_material, incline, cross_slope	status, pedestrian_lane, ada_compliance, detectable_warning, measured_length
	Tier 3	edge_id, street_name, edge_type, width, surface_material, status, incline, cross_slope, detectable_warning	from_node, to_node, width_min, separation_elements, buffer_width, bridge, surface_issue, pedestrian_lane, cross_slope_max, ada_compliance, impediment, date_built, check_date, visual_markings, measured_length
	Tier 4	edge_id, street_name, edge_type, width, surface_material, surface_issue, status, incline, cross_slope, impediment, detectable_warning	from_node, to_node, width_min, separation_elements, buffer_width, bridge, pedestrian_lane, cross_slope_max, ada_compliance, date_built, check_date, visual_markings, measured_length
footpath	Tier 1	--	--
	Tier 2	edge_id, edge_type	status, ada_compliance, detectable_warning

	Tier 3	edge_id, edge_type, width, surface_material, status, incline, cross_slope, detectable_warning	from_node, to_node, width_min, separation_elements, buffer_width, bridge, surface_issue, cross_slope_max, ada_compliance, impediment, date_built, check_date, visual_markings, measured_length
	Tier 4	edge_id, edge_type, width, surface_material, surface_issue, status, incline, cross_slope, impediment, detectable_warning	from_node, to_node, width_min, separation_elements, buffer_width, bridge, cross_slope_max, ada_compliance, date_built, check_date, visual_markings, measured_length
	Tier 1	edge_id, edge_type	--
	Tier 2	edge_id, street_name, edge_type, width, surface_material, incline, cross_slope	status, ada_compliance, visual_markings, detectable_warning, measured_length
	Tier 3	edge_id, street_name, edge_type, width, surface_material, status, incline, cross_slope, visual_markings, detectable_warning, ped_traffic_control	from_node, to_node, width_min, surface_issue, cross_slope_max, ada_compliance, impediment, date_built, check_date, traffic_calming, rail, vehicle_traffic_control , cross_vehicle_traffic_control , ped_protection, measured_length
crossing	Tier 4	edge_id, street_name, edge_type, width, surface_material, surface_issue, status, incline, cross_slope, impediment, visual_markings, detectable_warning, ped_traffic_control	from_node, to_node, width_min, cross_slope_max, ada_compliance, date_built, check_date, traffic_calming, rail, vehicle_traffic_control , cross_vehicle_traffic_control , ped_protection, measured_length
	Tier 1	--	--
	Tier 2	edge_id, edge_type	status, ada_compliance, detectable_warning
	Tier 3	edge_id, edge_type, width, surface_material, status, incline, detectable_warning	from_node, to_node, width_min, surface_issue, cross_slope, cross_slope_max, ada_compliance, impediment, date_built, check_date, visual_markings, measured_length
traffic_island	Tier 4	edge_id, edge_type, width, surface_material, surface_issue, status, incline, impediment, detectable_warning	from_node, to_node, width_min, cross_slope, cross_slope_max, ada_compliance, date_built, check_date, visual_markings, measured_length
	Tier 1	--	--
steps	Tier 2	--	--

	Tier 3	edge_id, edge_type, surface_material, status	from_node, to_node, surface_issue, ada_compliance, impediment, step_count, handrail, wheel_channel, visual_markings
	Tier 4	edge_id, edge_type, surface_material, surface_issue, status, impediment, step_count, handrail, wheel_channel	from_node, to_node, ada_compliance, visual_markings
	Tier 1	--	--
	Tier 2	--	--
	Tier 3	edge_id, edge_type, status	from_node, to_node, ada_compliance, visual_markings
escalator	Tier 4	edge_id, edge_type, status	from_node, to_node, ada_compliance, visual_markings
	Tier 1	edge_id, road_associated, edge_type, bikeway_type	separation_elements, separation_permeable_car
	Tier 2	edge_id, road_associated, edge_type, from_node, to_node, width, bikeway_type, separation_elements, separation_permeable_car, surface_material, incline	street_name, facility_name, bikeway_grade_separation, street_parking_buffer, status
	Tier 3	edge_id, road_associated, edge_type, from_node, to_node, width, width_min, bikeway_type, bikeway_grade_separation, separation_elements, separation_permeable_car, surface_material, status, incline	street_name, facility_name, buffer_width, street_parking, street_parking_buffer, date_built, check_date
bikeway	Tier 4	edge_id, road_associated, edge_type, from_node, to_node, width, width_min, bikeway_type, bikeway_grade_separation, separation_elements, separation_permeable_car, surface_material, status, incline	street_name, facility_name, buffer_width, street_parking, street_parking_buffer, date_built, check_date
	Tier 1	edge_id, road_associated, edge_type	--
	Tier 2	edge_id, road_associated, edge_type, from_node, to_node, width, surface_material, incline	street_name, facility_name, mup_modal_delineation, status, ada_compliance
mutli_use_path	Tier 3	edge_id, road_associated, edge_type, from_node, to_node,	street_name, facility_name, width_min, mup_modal_delineation, surface_issue,

		width, surface_material, status, incline	cross_slope, cross_slope_max, ada_compliance, impediment, date_built, check_date, visual_markings, measured_length
	Tier 4	edge_id, road_associated, edge_type, from_node, to_node, width, surface_material, surface_issue, status, incline, impediment	street_name, facility_name, width_min, mup_modal_delineation, cross_slope, cross_slope_max, ada_compliance, date_built, check_date, visual_markings, measured_length
trail	Tier 1	--	--
	Tier 2	edge_id, road_associated, edge_type, from_node, to_node, surface_material	street_name, facility_name, status, ada_compliance
	Tier 3	edge_id, road_associated, edge_type, from_node, to_node, width, surface_material, status	street_name, facility_name, width_min, surface_issue, cross_slope, ada_compliance, impediment, date_built, check_date, official, visual_markings, measured_length
	Tier 4	edge_id, road_associated, edge_type, from_node, to_node, width, surface_material, surface_issue, status, impediment	street_name, facility_name, width_min, cross_slope, ada_compliance, date_built, check_date, official, visual_markings, measured_length
virtual_link	Tier 1	--	--
	Tier 2	edge_id, road_associated, edge_type, from_node, to_node	--
	Tier 3	edge_id, road_associated, edge_type, from_node, to_node	--
	Tier 4	edge_id, road_associated, edge_type, from_node, to_node	--

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3.7.2 Edge Attributes

The following table lists all the edge attributes.

Name	Type	Description
edge_id	ID	A unique identifier for the edge. [NOTE: We will fill in instructions here on how to generate IDs, and we will also provide a data validator that may be capable of validating and helping to fill in these IDs.]
road_associated	Boolean	Specifies if the edge is adjacent or associated to a road. Valid Options: yes no
road_reference_id	Text	Unique identifier for a road segment from another source (ARNOLD, HPMS, TIGER, Census road network, OSM, etc.), used for joining that source to obtain more information about the road segment.
reference_ids	Array<Object>	Can be used to add reference IDs to other datasources such as OSM, OpenLR. Should be an array of JSONs with the source name and ID pair. Each JSON should contain an ID field and source field at minimum. Example: [{ "source": "OpenStreetMap", "id": "w1234" }, { "source": "TIGER", "id": "110739476769" }]
street_name	Text	Specifies the name of a road or the road associated with the edge, such as the street along which a sidewalk or cycleway runs. In many cases, routing engines can fill in the closest street name for travelers to see. Use this field to specify the associated street explicitly or to correct an error within routing engines. Example: "Maple Avenue"
facility_name	Text	The common name for this edge, by which travelers might recognize it. Example:

		"Atlanta Beltline", "Washington and Old Dominion Trail", "Minutemen Bikeway", "Lenape Trail", "East Coast Greenway"
edge_type	Enum	Identifies the edge type. Also used for assigning attributes that need to be filled in. Valid Options: road sidewalk footpath crossing traffic_island steps escalator bikeway multi_use_path trail virtual_link
from_node	ID	This field is used to identify the node where an edge begins. This information is needed for routing. Value needs to be from the nodes table in the node ID field.
to_node	ID	This field is used to identify the node where an edge ends. This information is needed for routing. Value needs to be from the nodes table in the node ID field.
directionality	Enum	Specifies the directionality of the edge. If the edge is bidirectional, choose “both.” Used to help identify when bicycle infrastructure allows traffic in both directions. If left blank, then assumes "both". Valid Options: forward backward both
width	Integer	The width of the edge at most points along its path. Measured in inches and rounded to the nearest inch. Cannot be negative.
width_min	Integer	The width of the edge at the point where it is narrowest. Measured in inches and rounded to the nearest inch. Cannot be negative.
bikeway_type	Text	Common name used for the bicycle facility type. Should align with the National Bikeway Network, NACTO, or AASHTO facility types. Recommended Options: Bike Lane Buffered Bike Lane Separated Bike Lane Counter-Flow Bike Lane Paved Shoulder Shared Lane
bikeway_grade_separation	Enum	The vertical level of the bikeway with respect to the road. Not meant for bikeways that are not road associated.

		Valid Options: at_grade raised sidewalk_level
separation_elements	Array<Text>	The materials used to separate the cycleway or footpath from motor vehicle traffic -- for example, as part of a buffer. Recommended Options: bollards concrete barrier parking median trees Example: ["bollards","concrete barrier"]
separation_permeable_car	Enum	Can a vehicle easily access this edge? Primarily intended for bikeways but could be used for pedestrian facilities. Valid Options: hard separator – the separator cannot be easily bypassed by motor vehicles (jersey barriers, curbs) soft separator – the separator can be easily bypassed by motor vehicles (flex posts, k-rail) none – no separator is present (just paint separation)
buffer_width	Float	Distance between the edge of the motor vehicle travel lane and the bike lane or sidewalk. Measured in feet and rounded to the nearest half foot. Cannot be negative. Example: 4
street_parking	Enum	Field intended to indicate orientation of street parking in relation to a bike facility. Floating street parking is also referred to as parking protected. Valid Options: parallel angled floating – Also known as parking protected. Put this value if present regardless if parking is parallel/angled parking.
street_parking_buffer	Float	The space between a bicycle facility and the street parking. Measured in feet and rounded to the nearest half foot. Cannot be negative.
traffic_volume	Integer	Measures the motor vehicle annual average daily traffic (AADT) for the edge. Reported with no more than two significant figures. Cannot be negative. Example: 1,540 would be 1,500

posted_speed_limit	Integer	Used to indicate the posted speed limit. Measured in miles per hour. Cannot be negative. If used on bikeway, multi-use path, or trail, it's assumed that is the speed limit for non-motorized users.
car_freeflow_speed	Integer	Used to indicate the free-flow motor vehicle speed. Suggest using the 85th percentile. Measured in miles per hour. Cannot be negative.
thru_lanes	Integer	Describes the number of vehicle thru lanes on an edge. Does not include turn lanes or shoulders. Cannot be negative.
aux_lanes	Integer	Describes the number of temporary vehicle lanes like turn lanes. Cannot be negative.
shoulder_width	Float	Width of the paved shoulder that can be used by pedestrians or cyclists. Measured in feet with one decimal point of precision. Cannot be negative. Example: 1.5
roadway_centerline	Boolean	Indicates if there is a painted road centerline. Might be a useful attribute to track for finding low-stress streets. Valid Options: yes no
bridge	Boolean	Indicates if the edge is or is on a bridge. Can be used for any bridge type, including road bridges and pedestrian bridges. Reccomend marking roads with bike lanes that are bridges. Valid Options: yes no
mup_modal_delineation	Boolean	Designates whether bikes and pedestrians have designated spaces on a multi-use/shared-use path, or whether all travelers use the same space. Valid Options: yes no Example: FALSE
prohibited_uses	Array<Enum>	Specifies which types of users are legally prohibited from using the facility, based on the laws, policy, or signage on a facility (ex. “E-bikes prohibited on this trail”). Can provide one or multiple in list form. Valid Options: walk bike ebike scooter motor_vehicle

allowed_uses	Array<Enum>	Specifies exceptions to the usually prohibited users. Intended for designating whether bikes are allowed to use sidewalks, footpaths, and crossings for routing purposes. Valid Options: walk bike ebike scooter motor_vehicle Example: Bicycles normally prohibited from using the sidewalk but the sidewalk is a critical edge for connectivity.
surface_material	Enum	Specifies the material used for the surface of the segment. Valid Options: asphalt concrete gravel grass dirt paved unpaved grass_paver paving_stones other
surface_issue	Text	Description of surface quality issues for the segment. If the quality is good, leave blank. Use the issue node to indicate quality issues at a single point, and this field to indicate quality issues that span the majority of the segment. Recommended Options: yes, no, cracking, scaling, spalling, overgrowth, uneven/displacement, frequent water pooling, heaving, missing bricks / stones, grates / utility covers / other surface impediments, potholes / holes, slickness, uneven joints, markings worn / missing, detectable warning surface damage, other
status	Enum	Most recent operating status of the segment. Whether the infrastructure is open and available for use. Valid Options: open, closed, under construction, unknown
seasonal	Array<Object>	Indicates whether the segment is commonly affected by seasonal issues. Use this field for recurring (ex. yearly flooding) and not one-time (ex. single flood) events. Include both the seasonal concern and the season when it occurs as a JSON String. Recommended Options:

		season: spring, summer, fall, winter seasonal issues: flooding, ice, snow, heavy rain, heat / lack of shade, low visibility, fog, wind Example: {"flooding":"spring","fall"}; {"ice":"winter","heavy rain":"summer"}
pedestrian_lane	Boolean	Indicates whether the stretch of sidewalk is a pedestrian lane, in which a section of the roadway surface is divided out for pedestrian use. Valid Options: true, false
incline	Float	The running slope of the full segment. Assume the given incline is in the forward direction of the edge, regardless of edge directionality. Report as percentage of the slope, with two decimal points of precision. Cannot be negative. Example: 3.25
cross_slope	Float	The cross slope of the edge at most points along its path. Cross slope is never reported in negative numbers. Report as percentage of the slope, with two decimal points of precision. Cannot be negative.
cross_slope_max	Float	The cross slope of the edge at the point along its path where there is the greatest slope. Report as percentage of the slope, with two decimal points of precision. Cannot be negative.
ada_compliance	Enum	States whether the piece of infrastructure was considered to be ADA compliant the last time it was officially assessed. This attribute should come from formal assessments and not be created using other available data (ex. Width, cross slope, etc.), since compliance status is based on many detailed, interacting factors. If ada_compliance is filled out, ada_compliance_date and ada_compliance_standard should also be filled out. Valid Options: yes, no, unknown
ada_compliance_date	Date	Indicates the date when ADA compliance was assessed. Report in ISO 8601 format containing month and year, or just year if month is not available. This field is conditionally required if "ada_compliance" is filled out.
ada_compliance_standard	Enum	The specific ADA guidelines or standards used in the assessment of this infrastructure. This field is conditionally required if "ada_compliance_standard" is filled out. Valid Options: 2010

			PROWAG other
impediment	Array<Text>	Description of surface quality issues for the segment. If the quality is good, leave blank. In levels 1-2, use this field for any surface quality issues. In level 3, use the issue node to indicate quality issues at a single point, and this field to indicate quality issues that span the majority of the segment. Recommended Options: yes, no, horizontal overgrowth, vertical overgrowth, fixed vertical obstruction, solid fixed object, flexible fixed object, protrusion, turning space missing or issue, detectable warning not aligned with crossing, push button not working, other
step_count	Integer	The number of steps that make up this set of stairs. Must be greater than zero.
handrail	Boolean	Whether a handrail is available on this set of stairs. Valid Options: yes, no
wheel_channel	Boolean	Whether there is a wheel channel to allow for pushing a bicycle up the stairs. Valid Options: yes, no
date_built	Date	Date containing month and year, or just year if month is not available. Indicates when the facility was officially opened for use. If the facility has had a major remodeling where the structure, shape or another fundamental aspect was changed, the date of remodeling can be placed here.
check_date	Date	The date that this infrastructure was last inspected. Report in ISO 8601 format containing month and year, or just year if month is not available.
traffic_calming	Array<Text>	Used to identify traffic calming features along a road or crossing. Implies that feature is present alongside the entirety of the edge. The fields that the traffic calming element(s) affect should be modified (i.e., a road narrowing should reduce the road's width field from its typical value). Recommended values are from https://www.ite.org/pub/?id=2a60c136-b1c0-b231-0522-ccbd075cac84 and https://wiki.openstreetmap.org/wiki/Key:traffic_calming Recommended Options: for road edge type: corner extension / bulb out, choker, narrowed road, chicane, closure, mini roundabout, diagonal diverter, lateral shift, median barrier/forced turn island, raised intersection, realigned intersection, road narrowing, speed hump, speed table, traffic circle for crossing edge type: raised crossing

curb_height	Integer	Indicates typical height of the curb along this segment of the road; can be used in deciding whether to route specific pedestrians off the sidewalk when there are obstructions or discontinuities. Measured and rounded to the nearest inch. Cannot be negative.
official	Boolean	Indicates whether a trail has been officially designated by a government body or other recognized organization. Valid Options: yes, no
presence	Enum	Indicates whether the piece of infrastructure exists or is present. When other attributes are provided, the existence of the infrastructure can be assumed. This attribute is useful for identifying where a sidewalk or a crossing might be missing or where its presence is unknown. Conditionally required if no other identfiying fields supplied. Valid Options: yes, no, missing, unknown Example: cycleway:left:presence=yes, cycleway:right:buffer:presence=yes
rail	Boolean	Used to indicate if a pedestrian or bicycle crossing is a railroad crossing. Use generic nodes to connect a rail crossing to the rest of the network. Valid Options: yes no
visual_markings	Text	The way the crossing is marked within the roadway space. “Standard” means two solid parallel lines that indicate the outline, “dashed lines” means two dashed parallel lines that indicate the outline, “zebra” means regularly spaced diagonal bars along its length, “continental” means regularly spaced horizontal bars along its length, and “ladder” means standard plus either zebra or continental. Recommended Options: yes no dashed lines zebra continental ladder other
detectable_warning	Enum	Indicates when tactile guidestrips or other markings are present to help identify the edge of a crosswalk or traffic island, the beginning or end of steps, or the presence of other infrastructure nearby, such as bike lanes. It is recommended to segment the edge so that

		this field is only equal to “yes” for the segment where the detectable warning appears. Do not use this field for tactile markings on curb ramps; instead, use the detectable_warning field for curb ramps. Valid Options: yes no unknown
vehicle_traffic_control	Enum	Describes how motor vehicle traffic that passes through the crossing space is controlled. Valid Options: uncontrolled standard signal flashing red signal flashing yellow signal yield sign stop sign
cross_vehicle_traffic_control	Array<Enum>	Describes how motor vehicle traffic coming from cross streets is controlled. This traffic may or may not turn into the crossing space. For intersections with more than one cross street, list all of the control types present. Valid Options: uncontrolled standard signal flashing red signal flashing yellow signal yield sign stop sign
ped_traffic_control	Enum	Describes the type of signal that controls the timing of pedestrian use of the crossing. Valid Options: Uncontrolled standard signal flashing red signal flashing yellow signal pedestrian hybrid beacon / HAWK rectangular rapid flashing beacon yield sign stop sign
ped_protection	Array<Enum>	Lists any features of traffic control that are intended to improve the protection of pedestrians while crossing. Valid Options: scramble / all pedestrian leading pedestrian interval no right on red none unknown

measured_length	Float	The measured length of the edge. Note that geospatial data also contains a length attribute by default that may be useful in some cases. Measuring the traversable length of the segment is preferable.

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3.8 Points

3.8.0 Point Types

This table lists all the allowed point types in GATIS.

Name	Description	Tier
object	A physical object that is likely to be of interest to travelers. Depending on the traveler, an object may be an amenity or an obstruction. Objects are represented as points and are not connected to the graph network. A buffer may be drawn around objects relevant to routing to create a node in the network at their location.	3

3.8.1 Recommended and Required Attributes for Points

This table gives an overview of the recommended and required attributes for points based on the type of point.

Point Type	Tier	Required	Recommended
object	Tier 1	--	--
	Tier 2	--	--
	Tier 3	point_id, point_type	object_type
	Tier 4	point_id, point_type	object_type

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3.8.2 Point Attributes

The following table lists all the point attributes.

Name	Type	Description
point_id	ID	A unique identifier for the point. [NOTE: We will fill in instructions here on how to generate IDs, and we will also provide a data validator that may be capable of validating and helping to fill in these IDs.]
point_type	Enum	Indicates the type of point. Valid Options: object

object_type	Text	Used to indicate objects that appear near the sidewalk or street space that, depending on the traveler, may be an amenity or an obstruction. Buffers around these points can be used to factor them into routing algorithms. If an object is on the pedestrian way, consider marking it with an issue node instead. Recommended Options: Bench, street lamp / lighting, waste basket, accessible restroom, inaccessible restroom, water fountain, parklet / kiosk, pet station

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3.9 Zones

3.9.0 Zone Types

This table lists all the allowed zone types in the specification.

Name	Description	Tier
pedestrian	Indicates a zone where pedestrians may travel freely in a range of paths they choose. Common areas to represent as pedestrian zones include parks and plazas. Pedestrian zones are represented as polygons that show the physical space taken up by the zone. If sidewalks or footpaths are present, map them separately as edges.	3

3.9.1 Recommended and Required Attributes for Zones

This table gives an overview of the recommended and required attributes for zones based on the type of zone.

Zone Type	Tier	Required	Recommended
pedestrian	Tier 1	--	--
	Tier 2	--	--
	Tier 3	zone_id, zone_type	surface_material, facility_name
	Tier 4	zone_id, zone_type	surface_material, facility_name

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3.9.2 Zone Attributes

The following table lists all the zone attributes.

Name	Type	Description
zone_id	ID	A unique identifier for the zone. [NOTE: We will fill in instructions here on how to generate IDs, and we will also provide a data validator that may be capable of validating and helping to fill in these IDs.]
zone_type	Enum	Indicates the type of zone. Valid Options: pedestrian

surface_material	Text	Specifies the surface type. Select only one. Where the surface material changes, create a new zone. Recommended Options: Asphalt; concrete; gravel; grass; dirt; paved; unpaved; grass_paver; paving_stones
facility_name	Text	Common or formal name for the zone. Can also include descriptions of a portion of a larger pedestrian zone if the zone is being segmented. Example: "Market Square", "21st Street Promenade", "Echo Park - West Side"

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5.0 Changes From Prior Versions

[Because this is V 1.X, this section is a placeholder.]

5.1 Known Limitations and Work Currently In Development

[Because this is V 1.X, this section is a placeholder. Please see the Appendix for information on some potential attributes that may be added, and for a couple proposals for how to approach some of the more challenging topics in the specification.]

6.0 Governance

GATIS is managed by [ORGANIZATION] through community consultation. Please visit [LINK] to review the overarching governance process for the specification.

6.1 Localization

This specification is deliberately designed to be extensible by anyone locally (i.e., on their own machine or within their own computing environment) with minimal to no effort. Allowing local flexibility is a deliberate decision to provide practitioners the ability to customize their data workflow. We want this specification to be an enabler, not a road block, to getting work done.

Anyone can add any attribute they want to a dataset. This specification's validator will warn about, but not fail on, new or unknown attributes, assuming they do not conflict with named attributes that are already defined as part of the specification.

6.2 Process for Changes

This specification will continue to grow and evolve as data practices and our infrastructure evolve. It was launched by a multisector collaboration, and it is governed in deep consultation with the community of data producers and consumers who rely on it.

6.2.1 Requesting a Change

We intend to monitor the ways in which others extend the specification and pull best practices to inform future versions. **Please share your thoughts, limitations you've found and workarounds.** You can share them at [LINK].

Here are some helpful things to include in your feedback or change request:

- A description of your real-world use case
- A demonstration or description of the problem with the current specification
- A description of the specific change you want to see
- Your contact information

6.2.2 Modifying the Specification

Consistent with the guiding principles that inform our work, there is a process to modify the specification. A description of this process and who is involved in decision making is maintained at [LINK].

GATIS is meant to be relatively easy for a range of stakeholders throughout the process from data collection to pipeline implementation to analysis and applications. Adding a new attribute raises the bar for specification users and requires updates.

When considering changes, demonstrated, real-world use will be considered as well as alignment with the Guiding Principles.

7.0 Tools

9.0 Related Specifications, References, and Other Resources

9.1 Related Specifications

The following specifications have a relationship with bicycle, pedestrian, and accessibility infrastructure. This specification is designed to be easily interoperable with them wherever possible.

Specification	Description	Interoperability
General Modeling Network Specification (GMNS)	GMNS is an extensible specification aimed at describing the entire transportation space, including physical elements, traffic controls and time varying policy elements. It includes representations of the physical transportation space (e.g., links, lanes, intersections, sidewalks, points of interest along a link), traffic controls (including signals) and time-varying policy elements (e.g., part-time lanes, restrictions on link or lane usage).	Bicycle and pedestrian facilities may either be modeled as attributes of a road link or as their own links. Nodes and edges within this specification can be integrated and joined with GMNS data in many cases.
Indoor Mapping Data Format (IMDF)	IMDF is primarily used to create accurate, geo-referenced digital maps of indoor spaces. It is often adopted for use in buildings like airports, malls, stadiums, arenas, and other complex indoor environments.	There are no explicit ties between IMDF and this specification, but IMDF could easily be used to continue to route through an indoor space. This specification can end a route at a transit stop (including station entrances and exits) or in front of other building types.

Open Sidewalks	The Open Sidewalks schema is used to create an internationally distributed pedestrian/bike transport graph layer, including infrastructure data for accessibility, safety, and pedestrian preferences. It includes extended attributes for advanced accessibility and route planning features. It builds on Open Street Map's tagging schema and community mapper model.	Interoperability with this specification is high, and many of the same data structures are shared.
Open Street Map (OSM)	OSM is a global, crowd-sourced map of infrastructure across transportation and within other domains. OSM covers bicycle, pedestrian, and accessibility aspects in depth.	OSM and this specification have many shared data structures, and data are highly interoperable. See the OSM Pedestrian Working Group's Schema to learn more about pedestrian features.
Overture Maps	Overture is creating global, interoperable, open spatial data that covers many aspects of the transportation system.	Overture data draws from OSM and uses many of their data structures, as well as layering on its own.
Curb Data Specification (CDS)	CDS expresses "dynamic curb zones" to improve parking, especially for delivery vehicles and passenger loading.	CDS and this specification have some connections at the curb space. CDS is a good source for real-time data related to curb management.
General Bike Feed Specification (GBFS)	GBFS represents the availability of docked and free-floating bikeshare, scootershare, and carshare. It connects data	This specification maps out public bicycle facilities. With a little effort, features such as bikeshare stations and parking can be integrated into a routable network created

	from bikeshare systems to consumer journey planning apps.	using this specification.
[General Transit Feed Specification (GTFS)]()	GTFS relays data from public transit agencies globally to provide public transportation information including stations, stops, routes and arrival information. GTFS-Pathways data are available for a subset of those agencies and describes the layout and accessibility of transit stations.	This specification includes GTFS agency_ids and stop_ids that can be used to pull in transit data from any available GTFS feed.
[National Bicycle Network (NBN)]()	NBN compiles bicycle route geospatial data for the U.S., based on data released by public agencies. It is managed by the Federal Highway Administration.	Many of the data structures in this specification align with NBN data structures.

Appendix

The following comprises work-in-progress content that was removed from the main body of this draft document. If useful, this material will be included in future document revision or via separate resources. It is included here to preserve the work and inform reviewers of the intent to cover these topics. Reviewers are invited to provide feedback on this content. As this material is work-in-progress, reviewers may wish to limit feedback to “this is helpful content, revise and include” or “this is not helpful content, omit,” and avoid more detailed editing.

Relation Tables

Relation tables describe the relationships for a selected collection of geospatial features. They can be used to model intersection treatments, such as bicycle two-stage left turns and turn restrictions. Each core geospatial entity included in a relation table should have a defined role that describes its place in the relation. The ordering of features in a relation table matters. After each core geospatial feature has had its role defined and its placement ordered, then attributes can be added to describe the relation. A two-stage left turn box (depicted in Figure 1) is used as an example for the structure of a relation table. Relation tables generally follow the format used for OpenStreetMap relations.

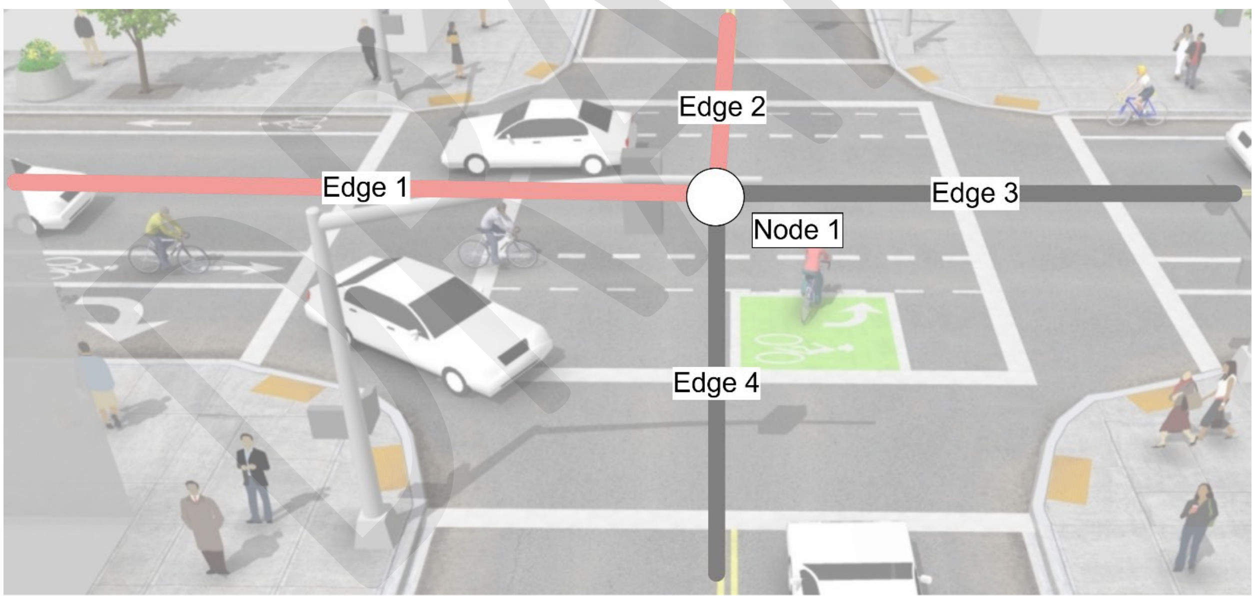

Figure 1: Example GATIS core geospatial features for representing an intersection with a two-stage left turn box (image from NACTO)

To model the two-stage left turn the relation table would be as shown in Table 2.

Table 2: Relation table for describing a two-stage left turn

Member	Core Geospatial Entity ID	Role	Relation Attribute
1	Edge 1	starting road	--
2	Node 1	intersection node	--
3	Edge 2	ending road	--
--	--	--	two-stage left turn

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At this time, the specification does not provide defined roles or attributes for relation tables. We expect to address relation tables more fully in the second draft of GATIS.

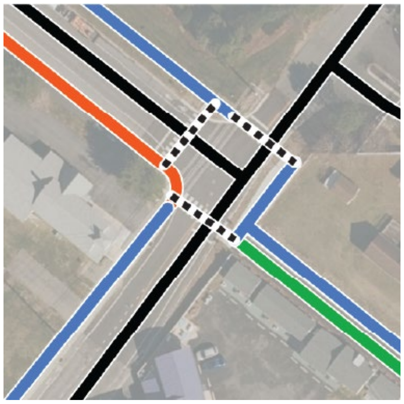
Intersections

Representing intersections is a critical part of modeling active-transportation infrastructure networks. Different transportation modes, speeds, volumes, and movements intersect with one another at intersections. As such, intersections often represent key connections or barriers to continuous active transportation travel. The specification helps users represent intersection infrastructure at each tier, to ensure modeled infrastructure information accurately reflects how it contributes or detracts from active-transportation infrastructure network connectivity.

We propose two approaches to modeling intersections for walking and bicycling: describing intersections with edges and describing intersections with relation tables.

Describing Intersections with Edges

When using the network representation for sidewalks, for example, crosswalks are digitized with their own spatial geometry (edge_type = ‘crossing’), and represent the path one would take to cross the roadway. If the location of curb ramps are also known, this provides significant insight into the length and exposure of the crossing, and we can spatially infer information about the nature of the roadway configuration and traffic from the roadway edge which is being crossed. This is describing an intersection with edges.

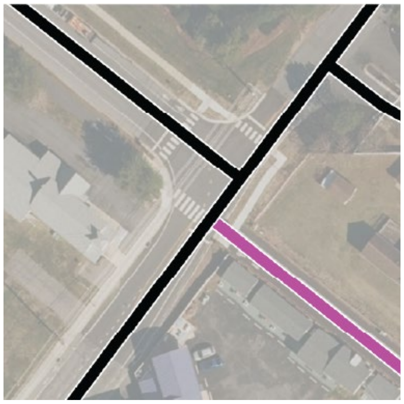


Describing a crossing with an edge is helpful because it provides a unique feature in the edge table which can be used to evaluate stress, delay, or other impedance measures of crossing the roadway at a defined location, and contain attributes that describe these and other characteristics of the edge (e.g., crossing_type = ‘continental’; width = ‘10 feet’).

Network representation makes it easier to understand where crossings and other edge features intersect. For example, where a crossing intersects a roadway centerline, the specification ensures the user can know how many lanes of traffic, traffic speed, and traffic volume on the intersecting edge a traveler using the crossing is exposed to.

Describing Intersections with Relation Tables

When using the centerline representation to model bicycle infrastructure, for example, there is no spatial geometry to describe the exact location or path of how someone bicycling would travel through an intersection. The intersection is represented as the convergence intersecting roadway edges. Because there are no individually modeled intersection crossing elements, the relationship between the approaching and departing edges would need to be documented in another format, such as a relation table. A relation table contains a unique row to describe the attributes of the connection between different pairs of intersection approach and departure edges.



Relation tables provide a flexible framework for describing how the physical or operational aspects of intersection edges affect the feasibility, comfort, or other characteristics of active transportation connectivity through an intersection.

The primary drawback of describing an intersection with a relation table is the added level of complexity associated with developing and maintaining a relation table, outside of the other geospatial datasets describing edges, nodes, or points. However, automated workflows can be used for developing these relation tables and spatially associating other data to the table, making this a more manageable task.

How to Model Common Bicycle Features

Refer to Recommended Practices For Digitizing Bicycle, Pedestrian, and Accessibility Infrastructure for basic explanations. The following section provides more detailed descriptions of how to model certain features. Examples include both network representation and roadway centerline representation.

Bicycle Facilities

Non-Roadway-Aligned Bike Facilities

In all cases, non-roadway-aligned bicycle facilities require a separate geometric feature to meaningfully represent them as a network representation.

Roadway-Aligned Directional Bike Lanes

For roadway-aligned bicycle facilities, there may be ambiguity about whether the bike facility is best represented as a separate geometric feature (network representation) or if it can be represented using attributes on the roadway centerline (centerline representation).

Directional, roadway aligned bike lanes (where bike lanes are on both sides of the street and follow the prevailing legal direction of travel) should be described with the centerline representation, using attributes of the roadway to physically describe the bike lane (refer to Edges).

Roadway-Aligned, Separated, Bidirectional Bicycle Facilities

Roadway-aligned, separated, bidirectional bicycle facilities describe a two-way bike lane located on one side of the street that is physically separated from automobile traffic. These facilities may be described with the centerline representation or the network representation. The network representation approach provides more detail than the centerline representation approach, which is likely important for modeling the characteristics of such facilities as part of a network. However, both representations are valid and supported. Below are some considerations regarding approach:

- Is crossing the road to access the bidirectional bike lane, in order to turn right, a high-stress maneuver which presents a barrier to low-stress cycling? If so, the bike lane should be described with the network representation using a separate geometric figure.

- Is the separation between the bike lane impermeable to entry and exit of people bicycling at minor intersections, entrances, or destinations? If so, the bike lane should be described with the network representation using a separate geometric figure.

Roadway-Aligned Multi-Use Pathways (‘Sidepaths’)

Roadway-aligned multi-use pathways, known in some jurisdictions as sidepaths, should be described with a separate geometric feature to meaningfully represent them using the network representation. Sidepaths are typically separated from the roadway by a curb, a grass buffer, or some other separation which is nominally impermeable to cars. Sidepaths which are not as separated from the roadway can be described using the centerline representation and edge attributes.

Other Features

The following ideas for attributes are listed here to allow for reactions:

- **Curb ramp landings**. The draft does not currently include whether landings at the top and bottom of curb ramps are present, and it does not include the attributes of these landings such as width and slope.

- **Curb ramp geometry**. Additional details on curb ramp geometry, including blended transitions and cut-outs. Many other details about the navigability of curb ramps are included.

- **Signage**. The draft doesn’t include a means of tracking signage that conveys information about closures, permitted uses and other key information. It also does not include a way to track the accessibility of this signage for a range of users.

- **Traffic noise.** Some local and state governments may have edge-level data about traffic noise. An appropriate federal data source could not be identified. The draft has no attribute, but this data can be blended if available.

- **Level of stress for bicyclists and pedestrians**. In the Guiding Principles and in our conversations, we've veered toward describing the infrastructure and avoiding subjective or modeled data. The attributes in the draft include common features for LTS models, and this was seen as the best way the specifications could contribute to LTS analysis. Should LTS be added to the second draft, it would include a link to the specific methodology used.

- **Transit boarding / alighting areas**. Whether a transit stop is an entrance or exit. This attribute was in a version of the draft, but the tendency of this draft is to avoid duplication with other specifications and schemas. Because this attribute is within GTFS, it was removed.

- **Crossings split at the point where traffic direction changes**. This could be used to add more detail to the crossings, such as how many lanes are crossed in each direction, and how bike infrastructure intersects with crossings.

- **Forbidden turns**. The draft does not currently cover places where motor vehicles are not allowed to turn right or turn left. Adding this attribute could enhance understanding of pedestrian and bicyclist safety at intersections.

Signals

Signal infrastructure—such as pedestrian push buttons, pedestrian detectors, and signal poles that convey auditory or tactile information about the signal and its messaging—are important for accessible travel.

We're considering two approaches to signals. One approach attaches information about the signals to edges. The other treats signals as nodes.

In both approaches, the location being tracked is where pedestrians must go to interact with the signal—to push a signal button, to hear and trigger auditory messages, or to access tactile information. The location of the signal head itself is not tracked.

In both approaches, the following attributes that are used above for edges and nodes would also be tracked:

- presence

- date_built

- date_checked

- ada_compliance
- ada_compliance_date
- ada_compliance_standard

We would also add the following four attributes specific to signals:

- features: Tactile vibration, tactile arrow, auditory walk indication, pushbutton locator tone, other auditory messaging, other
- triggering: Pedestrian actuated / push button, pedestrian auto-detected, no actuation or detection, unknown
- crossing_time: Measured in seconds. If crossing time is not fixed, the minimum crossing time would be listed.
- issue: Push button not working, broken / damaged, auditory signal not working, vibrotactile signal not working, poor volume, button height issue, no visual countdown, distance from walk path, other.

Option #1: Signals on Edges

Data about signals could be added as attributes to crossing edges. Because there will be signal infrastructure at two or more points on an edge, there would need to be tagging to indicate which signal location is being referenced, so that issues can be associated with the correct infrastructure and any differences from different approaches can be marked correctly.

The benefit of this approach is that it relies on existing structures with the specifications and hopefully keeps the overall data model a little simpler. It also helps to keep it clear which signals are associated with which crossings.

Option #2: Signals as Points

Signal locations could be identified as points, showing their exact location within the intersection space. A virtual link (a type of edge described above) could be used to associate the point with the correct crossing. This virtual link would not be routable.

A buffer could be created around signal points and then used to add nodes to the network to enable routing. Doing so would put the node for the signal on the right location on the sidewalk edge, helping pedestrians to be routed to the signal on their way to the curb ramp, regardless of the direction from which they approach.

The benefits of this approach are being able to accurately mark the location of the signal infrastructure, and enabling routing directly to the signal location. The latter can help a range of travelers with different mobility profiles, including blind and low vision travelers, to be able to more easily navigate and take advantage of signals for comfortable, safe travel.