GMNS*: A Specification for Sharing Routable Multi-Resolution and Multi-Modal Networks

2024-07-25

*General Modeling Network Specification

Motivation (1/2)

- Gaps in multiresolution modeling, recognized for many years, by the travel modeling community
- Desires
  - An open specification for routable networks with several levels of resolution
  - Support models ranging from static routing over a large area to microsimulation
  - Capture details on Complete Streets and, potentially, ADA accessibility

$\longrightarrow$ Avoid the expense of network redevelopment from scratch with every new project

Motivation (2/2): these are not the same!

Source: Google Street View

Source: Google Street View

These are both multi-lane arterials with bus stops. But they are different from a pedestrian, bicyclist, transit-user perspective.

Relevance to NC-BPAID's work

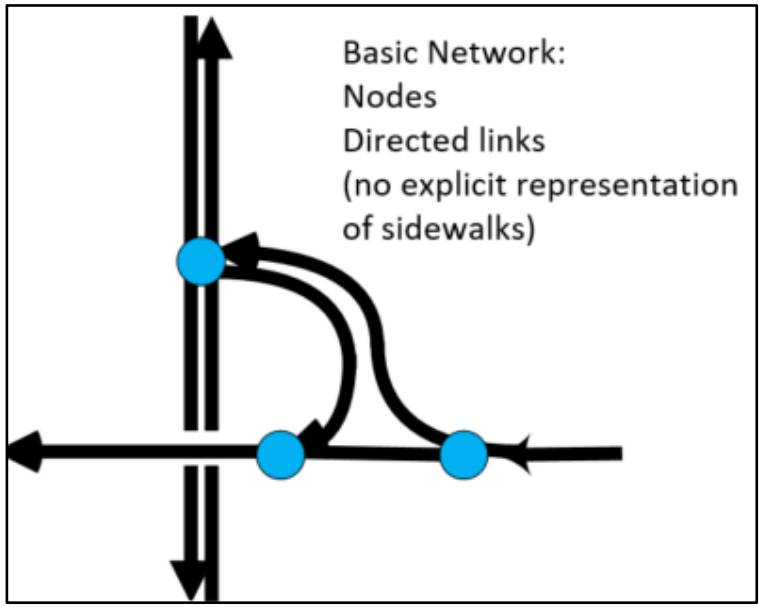
- Similar objectives
  - Routable multi-modal networks
  - May aid the work of the Specification Development Subgroup
- GMNS has considered some of the issues that have arisen here
  - For example, pedestrian facilities on the road link or as their own links
  - Multi-modal routing
- Some tools have already been built to use GMNS
  - Conversion from OpenStreetMap
  - Routing
- May save some time for NC-BPAID to at least be aware of the GMNS effort

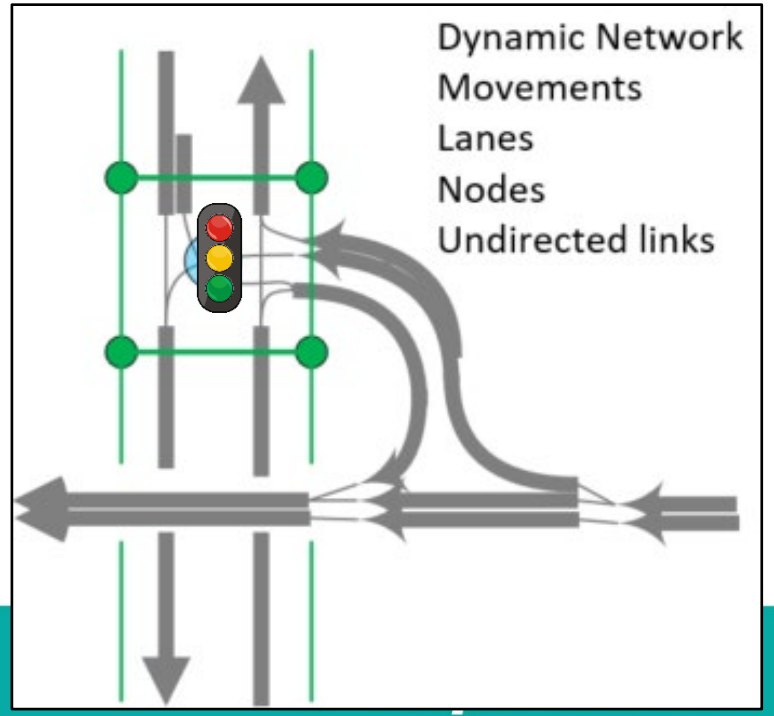
GMNS: High level requirements

1. GMNS is a data specification, not tied to any specific software tool
2. GMNS is extensible, not universal
   - The only required files are nodes and links, to support static network assignment
   - Specification accommodates user-defined fields
3. Extensions include data needed for dynamic, multi-modal networks
4. GMNS reflects infrastructure, services and policies:
   - physical roads
   - intersections
   - traffic controls
   - tolls
   - time-of-day restrictions
5. GMNS is human and machine readable

GMNS …

- Supports multi-resolution modeling projects
- Encourages more consistent practices by state and local governments for coding facilities, to ease automated processing of public data
- Supports multi-modal (car, truck, transit, pedestrian, bike) improvements
- Brings time-varying varying networks into transportation planning, to better incorporate the effects of transportation system management and operations (e.g., varying lane configurations and tolls)





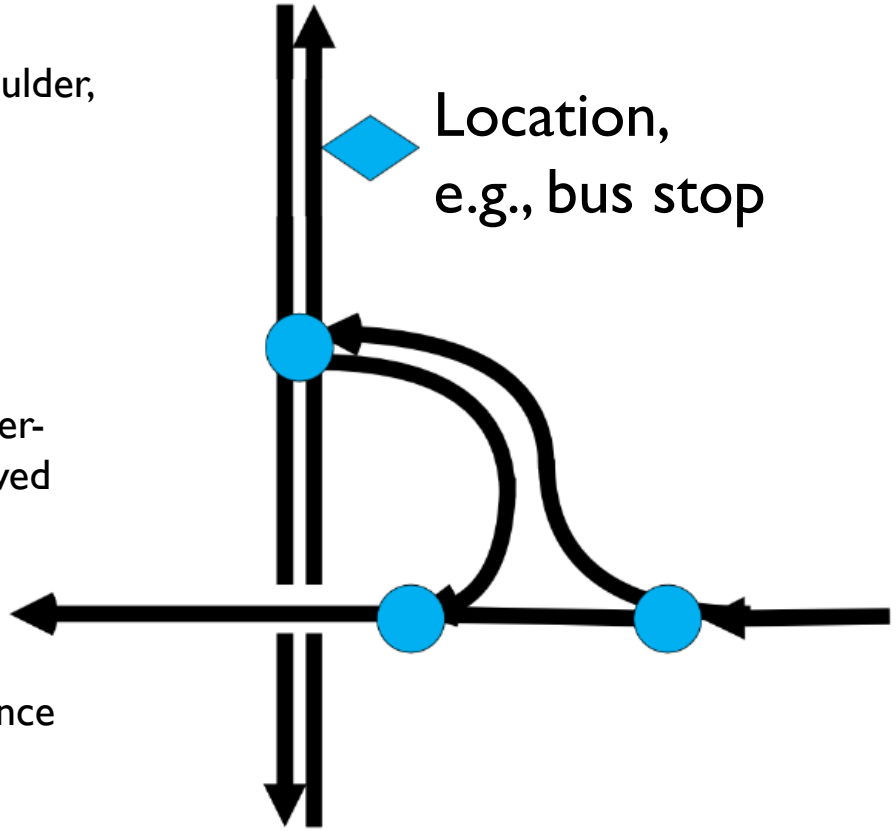
Multimodal Accommodation in GMNS (1/2)

Fields on the link table
(attribution on a roadway centerline)

- **allowed_uses**:
  - indicates what may flow on a **link** or **lane**, as well as non-travel uses (shoulder, parking)
  - Example values: walk, bike, bus, truck, auto, hov
  - Can define "use_groups" to aggregate multiple uses
- **bike_facility:**
  - Datatypes based on National Bikeway Network schema
  - none, unseparated bike lane, buffered bike lane, separated bike lane, counter-flow bike lane, paved shoulder, shared lane, shared use path, off-road unpaved trail, other, unknown
- **ped_facility:**
  - unknown, none, shoulder, sidewalk, offstreet path

Location: point associated with a specific location along a link, using linear reference

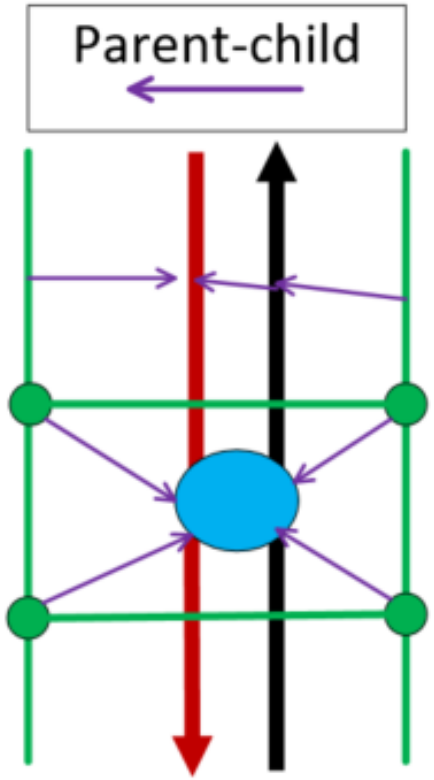
- Transit stations, bus stops
- Ride-hailing / taxi pickup points
- Shade trees?



Multimodal Accommodation (2/2)

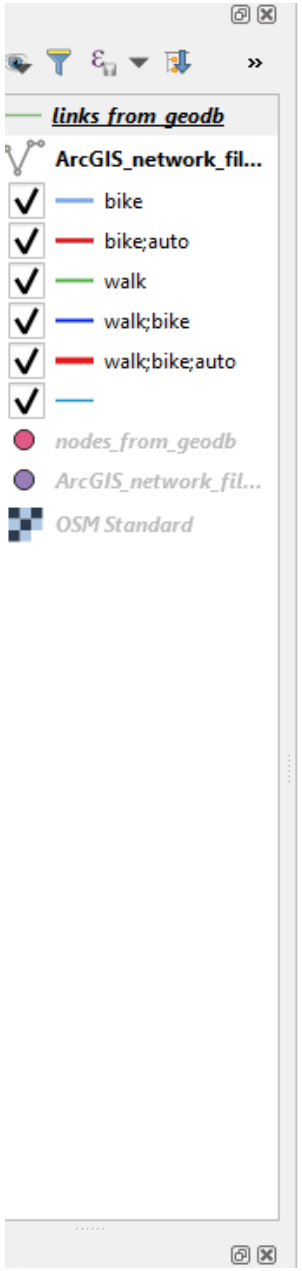
(separate centerlines)

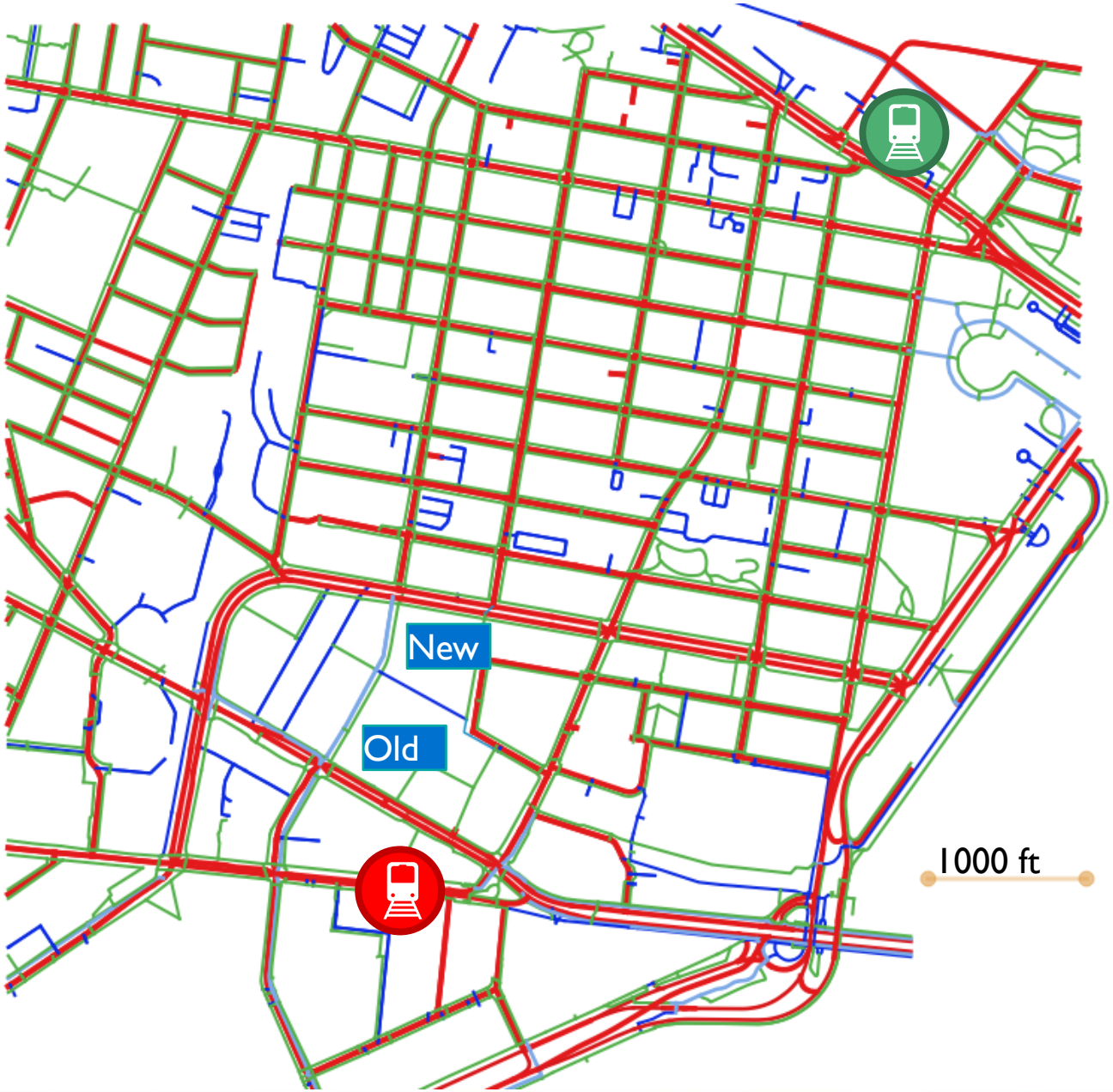
- Sidewalks and crosswalks may optionally be handled via their own undirected links.
- Parent-child relationships
  - Sidewalk with associated road
  - Crosswalk with associated intersection node
- Separated bike lanes may be handled via their own directed links
- Off-road paths are their own links



Multimodal network - Case study

- Cambridge MA, area around the Volpe Center
- Network generated from OpenStreetMap
- Car, bicycle, pedestrian
- Includes
  - 2 transit stations
  - Sidewalks
  - Shared use paths
  - Several types of on-road bicycle accommodation
- Modeled pedestrian and bicycle impedances based on
  - Type of facility
  - Road functional class





Details

Red – Roads open to motor vehicles

Purple – Bike only

Cycle track

Contraflow bike lane

Blue – Bike and pedestrian

Green – Pedestrian

Pedestrian and bike facility representation:
1. Attributes of the road

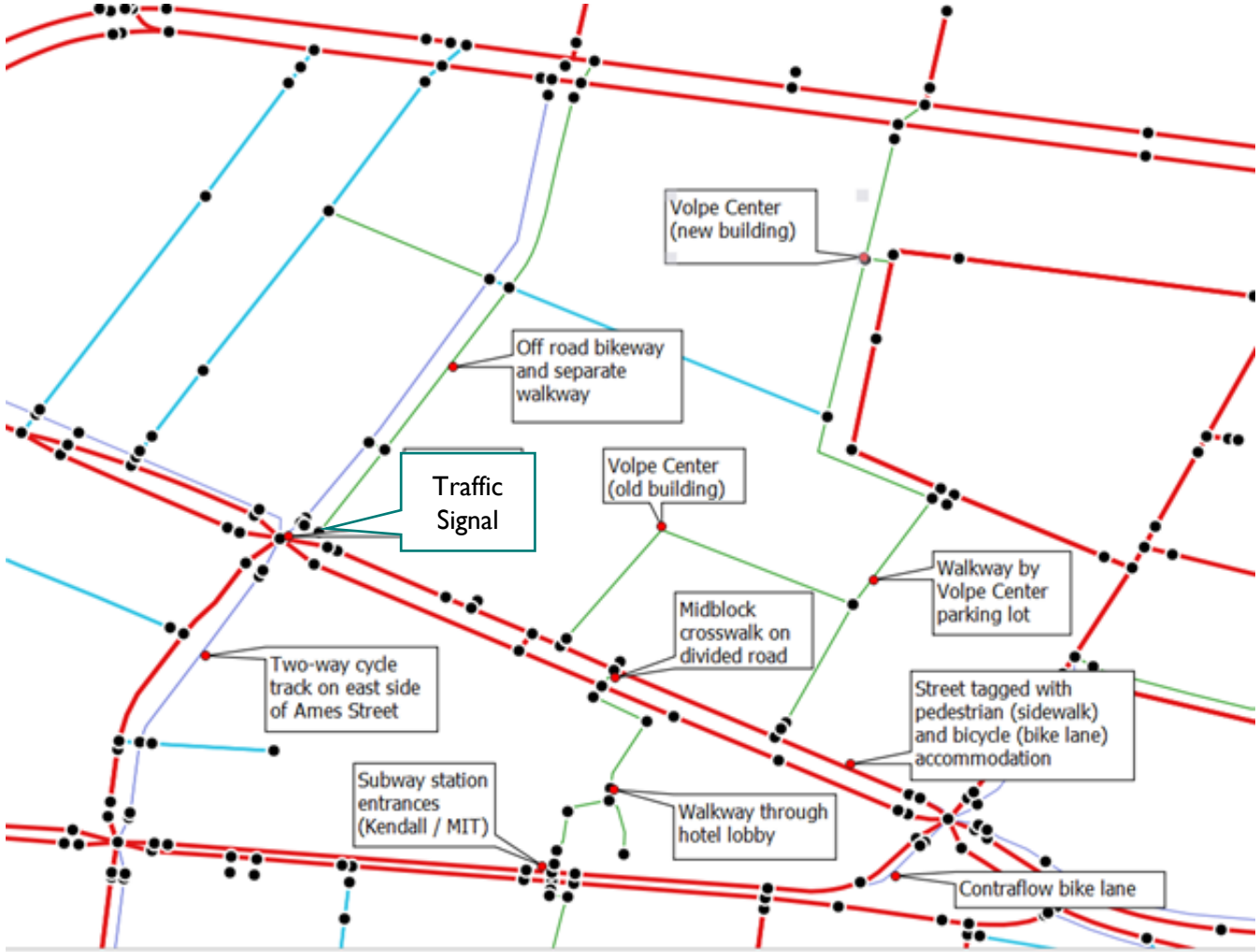
Sidewalk

Unseparated bike lane

2. Their own links

Off road walkway or bikeway

Separated or contraflow bike lane



Walk access to destinations (with or without ------)

Without a connection

With a connection

+6% accessible area within 5 min of walking

 Source: Michael Dunst STIPDG Project Presentation

Other elements

In GMNS

- Details on lanes of all types
  - Street, bike facility, sidewalk
  - Pocket lanes
  - Allowed uses, width
- Slopes and altitudes
- Time varying networks
- Intersections
  - Turning movements
  - Traffic controls (including traffic signals)
  - Crosswalks
- Basic transit integration

Not explicitly in GMNS

- Traffic volumes
  - Handle via supplemental tables
- ADA details and facility condition
  - Could easily be added
  - Let's discuss!

Use cases

- Determine gaps in the network for bicyclists, pedestrians and persons with disabilities
- Measure community progress on building a more inclusive transportation system
- Reduce barriers to working with routable network data
  - Same format nationwide, with consistent core data fields
  - Give local communities a starting point
  - A common specification that can be used by several applications
- Facilitate development of wayfinding maps and apps
  - Similar to what a standardized feed (GTFS) did for transit

It takes a community…

tools that work with GMNS

Network synthesis:

- **osm2gmns** for nodes, links, movements
- **signal4gmns** for traffic signals
- **NeXTA4gmns** for visualization and editing

Multiresolution network expansion:

- **net2cell**

Validation tools:

- **gmnspy** for format validation (does the network conform to the spec?)
- Graph validation (is the network connected?)

Shortest path and routing:

- **path4gmns,** with connection to **DTALite**
- **AequilibraE**

We improve the specification by using it

With thanks to Xuesong Zhou, Pedro Camargo, Elizabeth Sall and others

For more information

GitHub:

https://github.com/zephyr-data-specs/GMNS

Zephyr Project Management Group:

https://zephyrtransport.org/projects/2-network-standard-and-tools

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