SmartPT

Funded by ERA-NET Transport III
Flagship Call 2013 "Future Travelling"

era-net TRANSPORT

hEART

September 10, 2015

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Integrating OSM and GTFS to create MATSim plans using PT

- Introduction
- Problem statement
- Previous attempts made by others
- OpenStreetMap (OSM)
- General Transit Feed Specification (GTFS)
- Solution
- Results
- Brooker

Introduction

- Activity-based transport micro-simulations
  - Travel demand
  - Network loads
- Simulating public transport
  - Capacity utilization

Problem statement

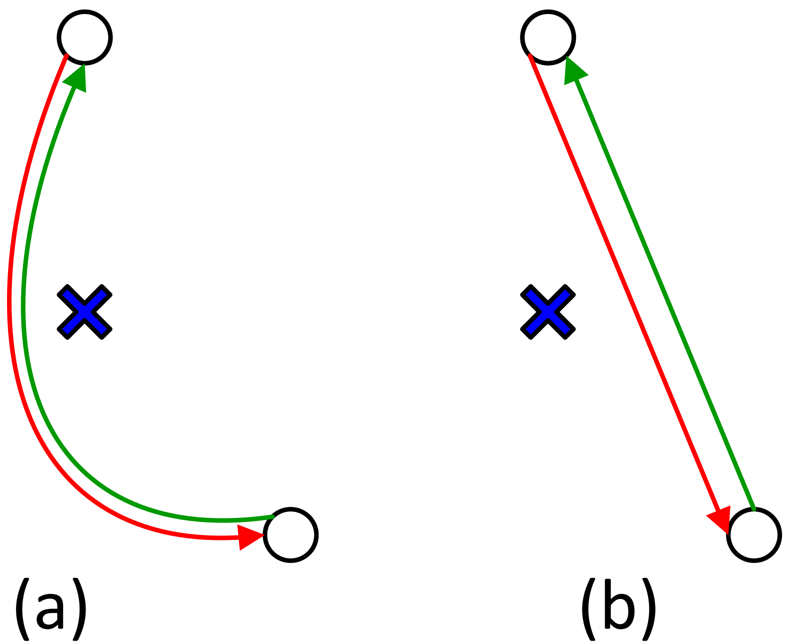
- Automate integration of
  - OSM (OpenStreetMap) network
  - Public transport schedules from GTFS (General Transit Feed Specification)

- +/-31.000 bus stops in Flanders
  - No 100% positional accuracy

- Open source data is frequently updated

Previous attempts made by others

- MATSim extension: GTFS2TransitSchedule



OpenStreetMap (OSM)

- Advantages
  - Free
  - Frequent updates
  - …

- Disadvantages
  - Lack of rules for adding data
    - Inconsistent data
    - Duplicate data
    - Incorrect data (number of lanes, weakly connected network, etc.)
    - …

OSM cleaning

- Filtering road types
- Resetting incorrect individual values
- Auto complete data (e.g. total number of lanes)
- Reset incorrect values for related quantities
- Add missing data through rules (FFspeed, capacity, BPR, …)
- Remove links having zero length
- Merge GeneralTransportInfrastructures (includes junctions)
- Merge GeneralLinks (trivial node processing)
- Strongly maximum connected subgraph
- Split GeneralTransportInfrastructures (Digraph)

General Transit Feed Specification (GTFS)

- Minimum set of tables
  - Agency
  - Stops
  - Routes
  - Trips
  - Stop times
  - Calendar

Overview: Problem - Solution

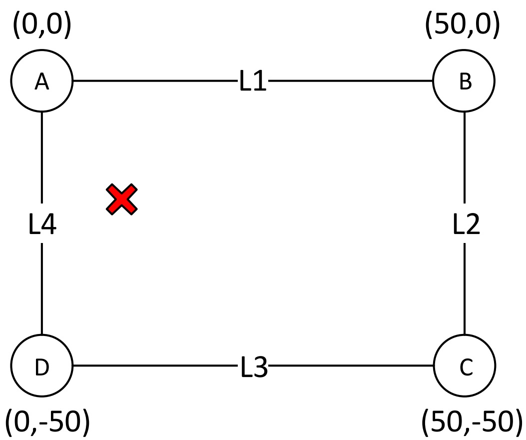
- Problem
  - Using geometry, assign GTFS stops to road segments
  - A GTFS stop can meet several links
  - Problem: *Select exactly one assignment for each GTFS stop*
- Solution
  - Apply name based heuristic
  - Assume that PT operator opts for the smallest total distance over trips (*optimization criterion*)
  - Checking all possible combinations is infeasible
  - Assign as many stops as possible using local context only
  - Decompose into *set of small optimisation problems*

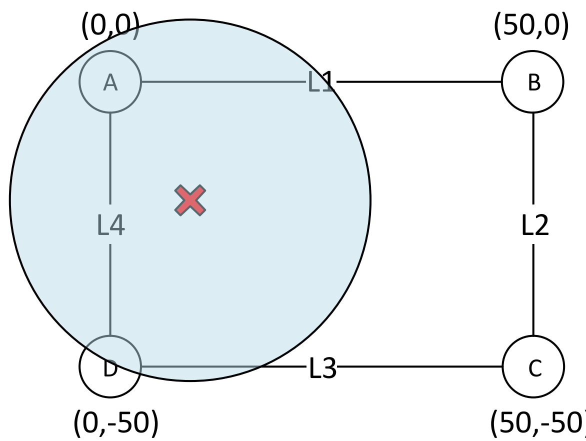
Solution

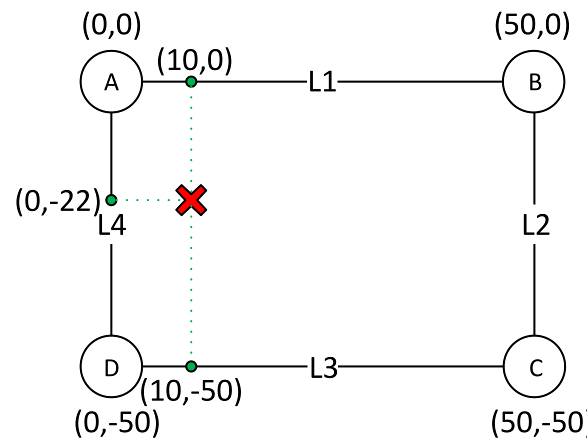
- Step 1: Find projected stops
- Step 2: Reduce candidates
- Step 3: Create directed graph (projected stops)
- Step 4: Assign unambiguous GTFS stops
- Step 5: Assign ambiguous non-shared GTFS stops
- Step 6: Assign ambiguous shared GTFS stops

Solution

- Step 1: Find projected stops

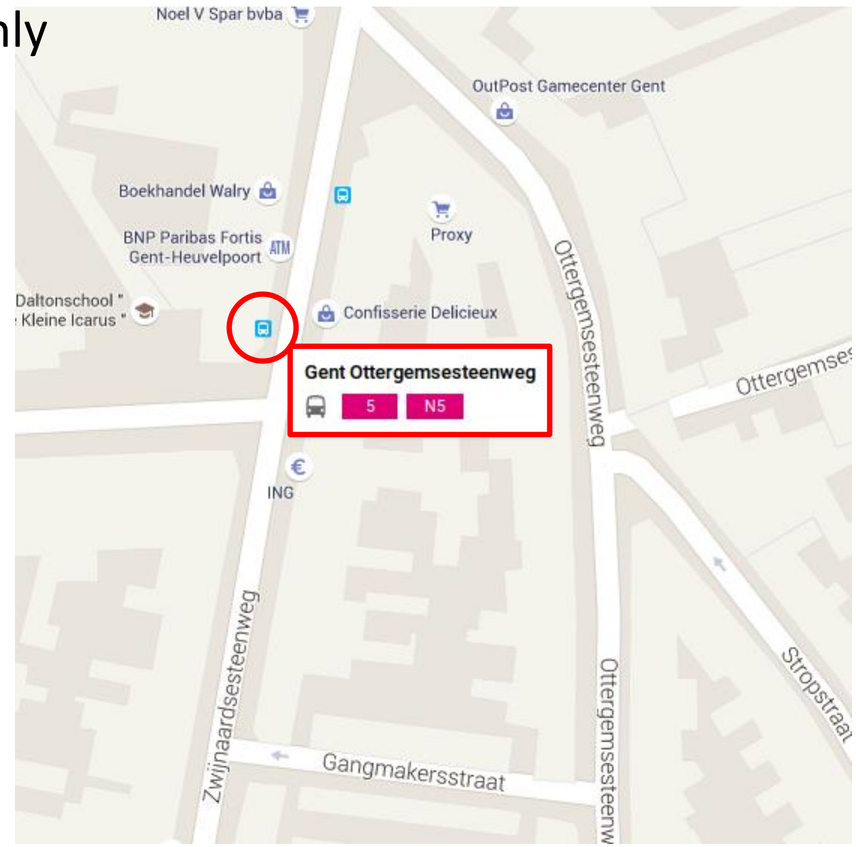






Solution

- Step 2: Reduce candidates
  - Based on street names and GTFS stop names
    - Geometrically nearest link only
  - Using Levenshtein distance

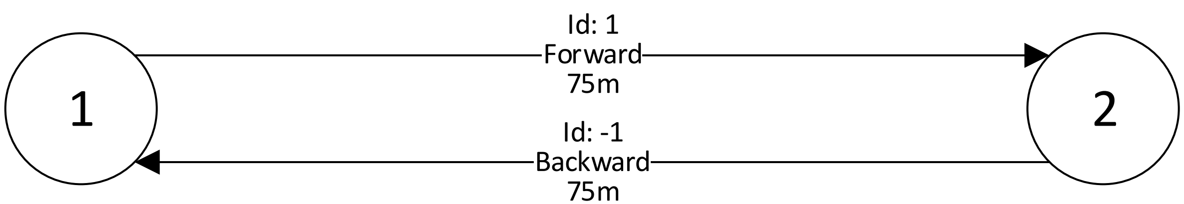


Solution

- Step 3: Create directed graph
  - Challenge: one GTFS stop generates multiple projected stops (3 having the same <x,y> in this case)

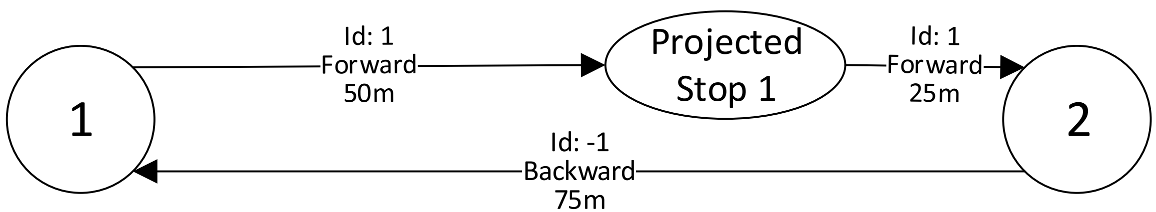
Solution

- Step 3: Create directed graph
  – Add projected stop 1 on link with id 1, not coinciding with any node



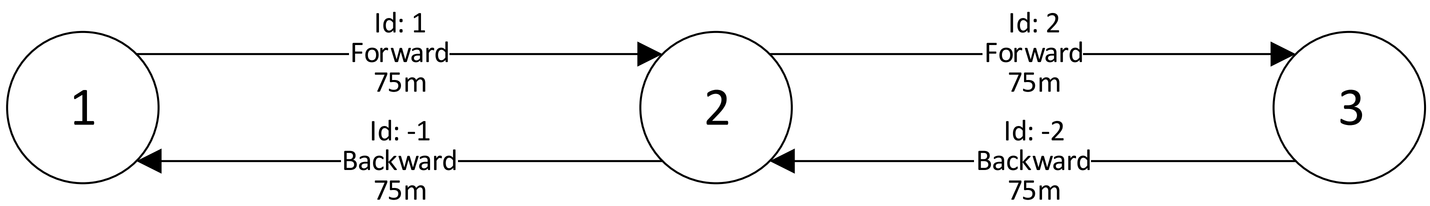
Solution

- Step 3: Create directed graph
  - GTFS stop generates projected stops on both directed edges



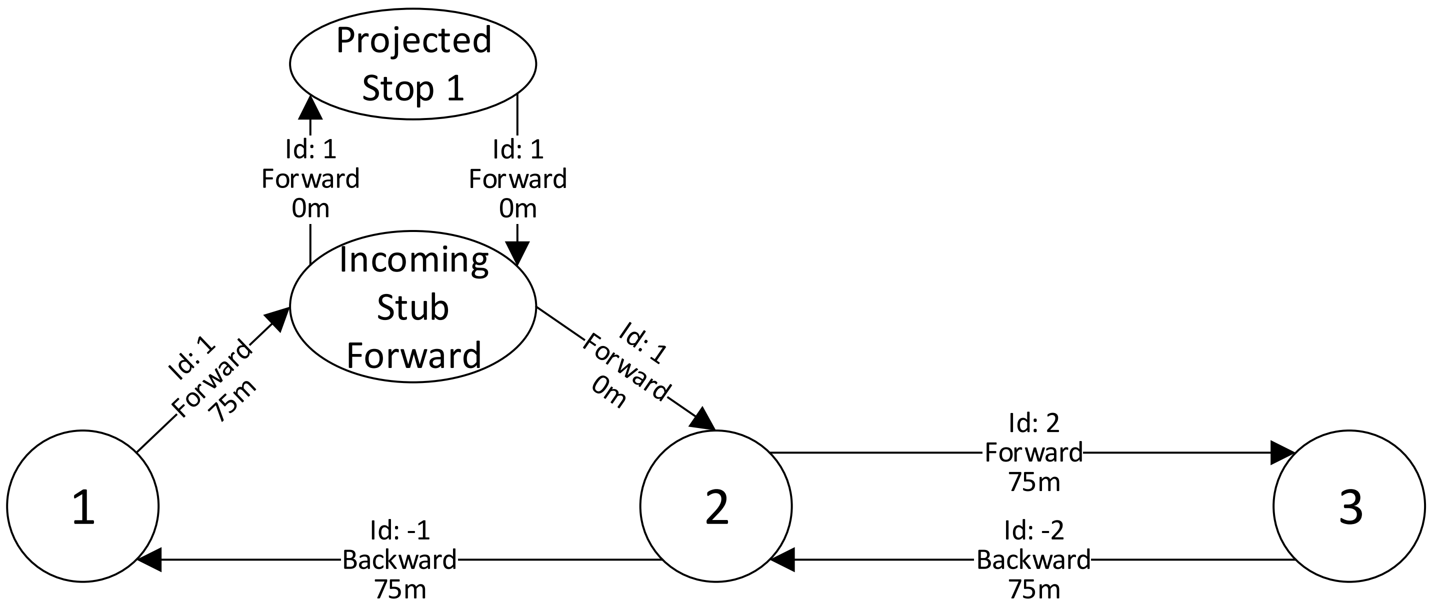
Solution

- Step 3: Create directed graph
  - Add projected stop 1 on link with id 1, coinciding with node 2



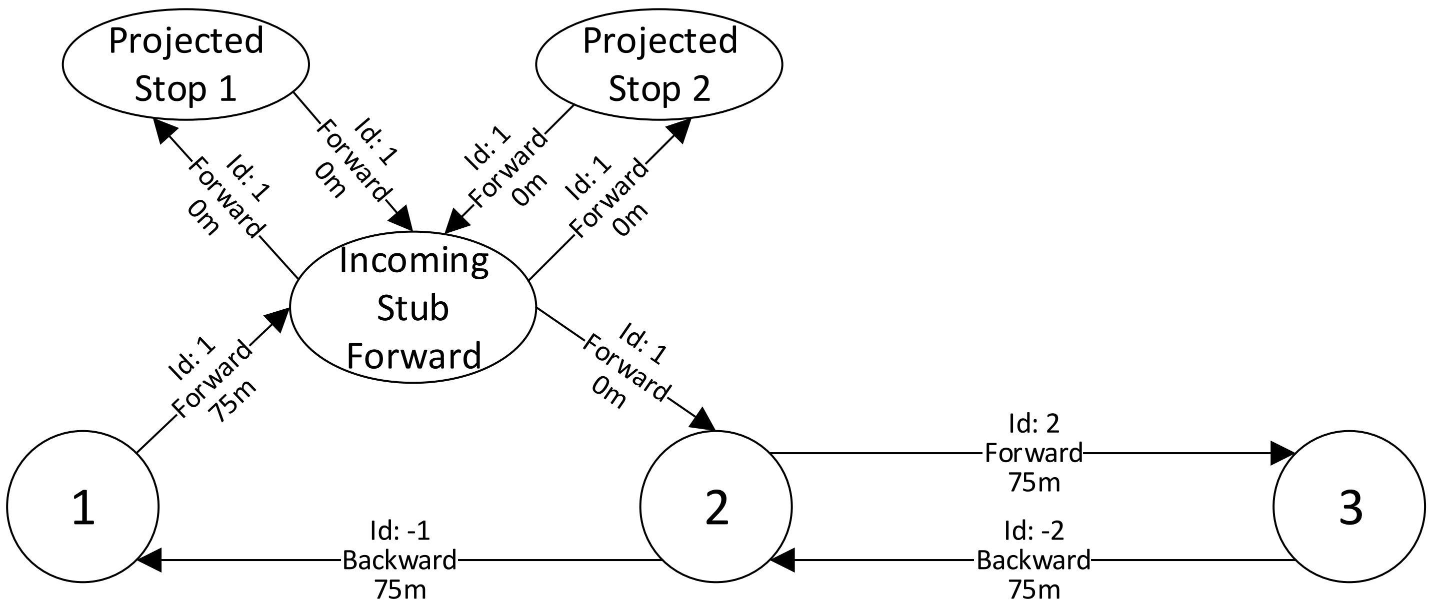
Solution

- Step 3: Create directed graph
  - Add projected stop 2 on link with id 1, coinciding with node 2



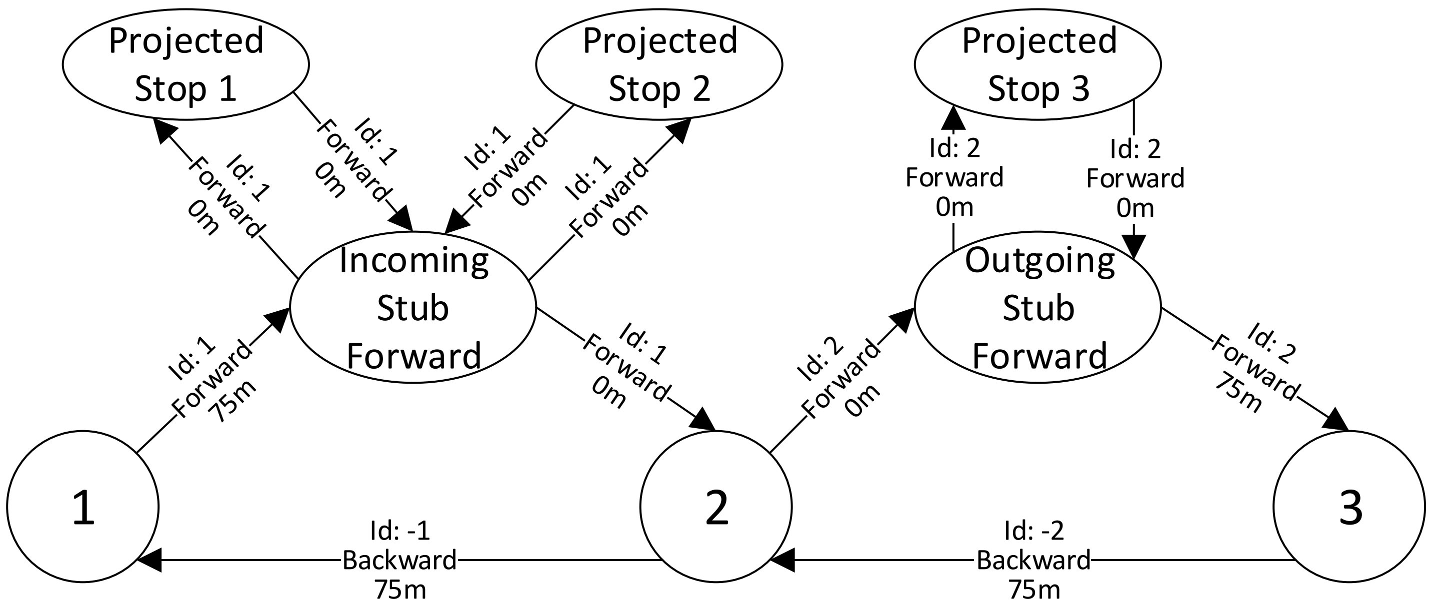
Solution

- Step 3: Create directed graph
  - Add projected stop 3 on link with id 2, coinciding with node 2



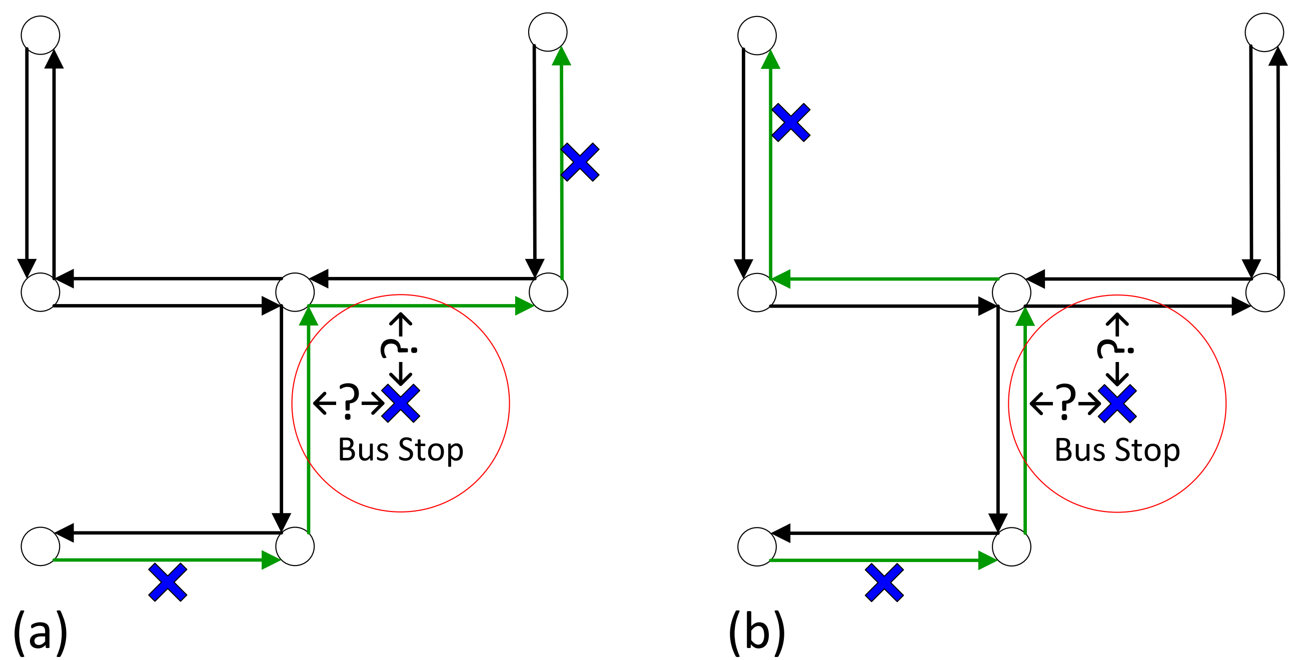
Solution

- Step 3: Create directed graph



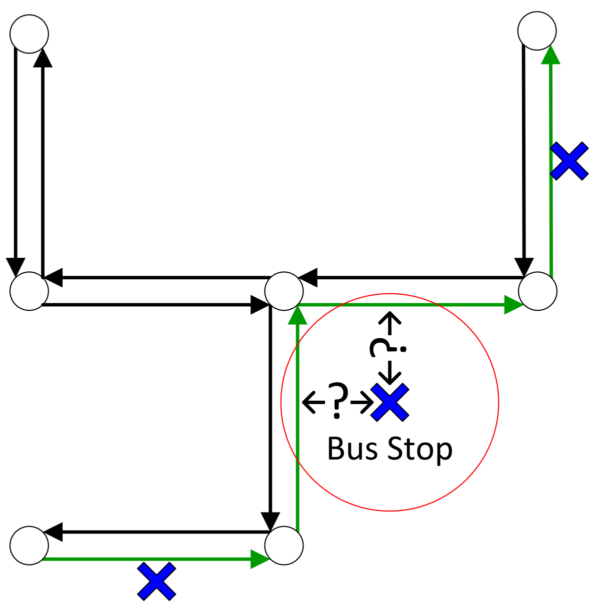
Solution

- Step 4: Assign <u>unambiguous</u> GTFS <u>stops</u>
  - Shortest distance between consecutive stops
  - Does not mean that complete solution for trip is found



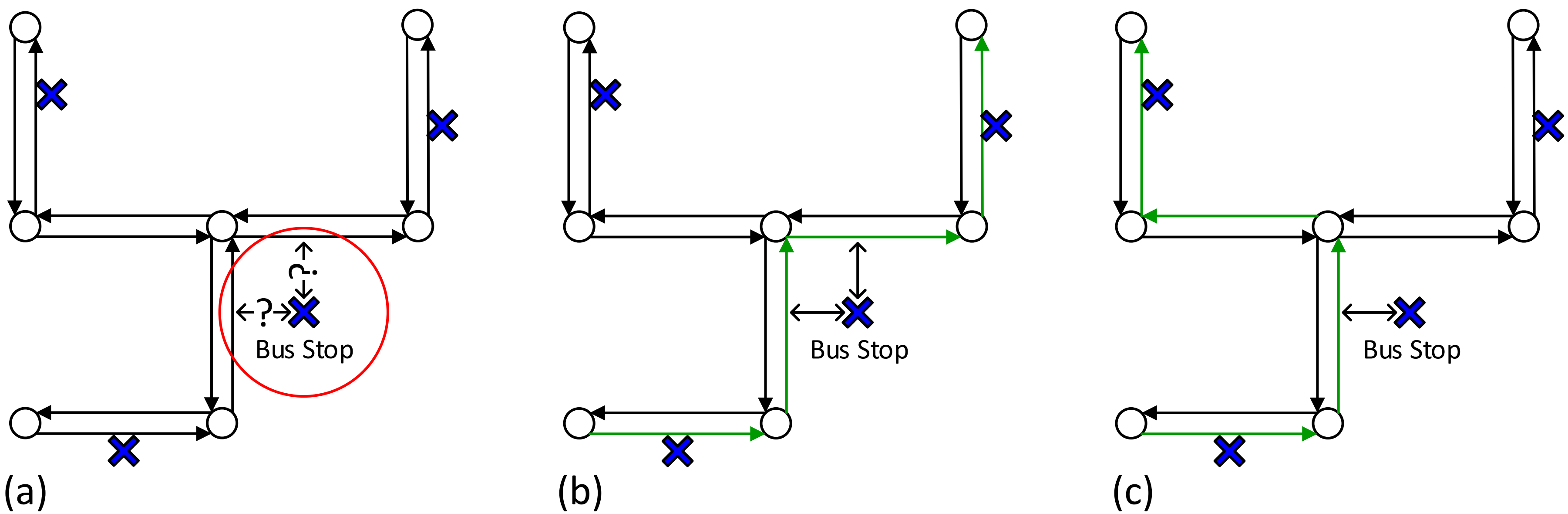
Solution

- Step 5: Assign ambiguous non-shared unassigned GTFS stops
  - For each GTFS stop exactly one Projected stop is to be chosen such that
    - The sum of the path weights (distances) is minimal over single trip



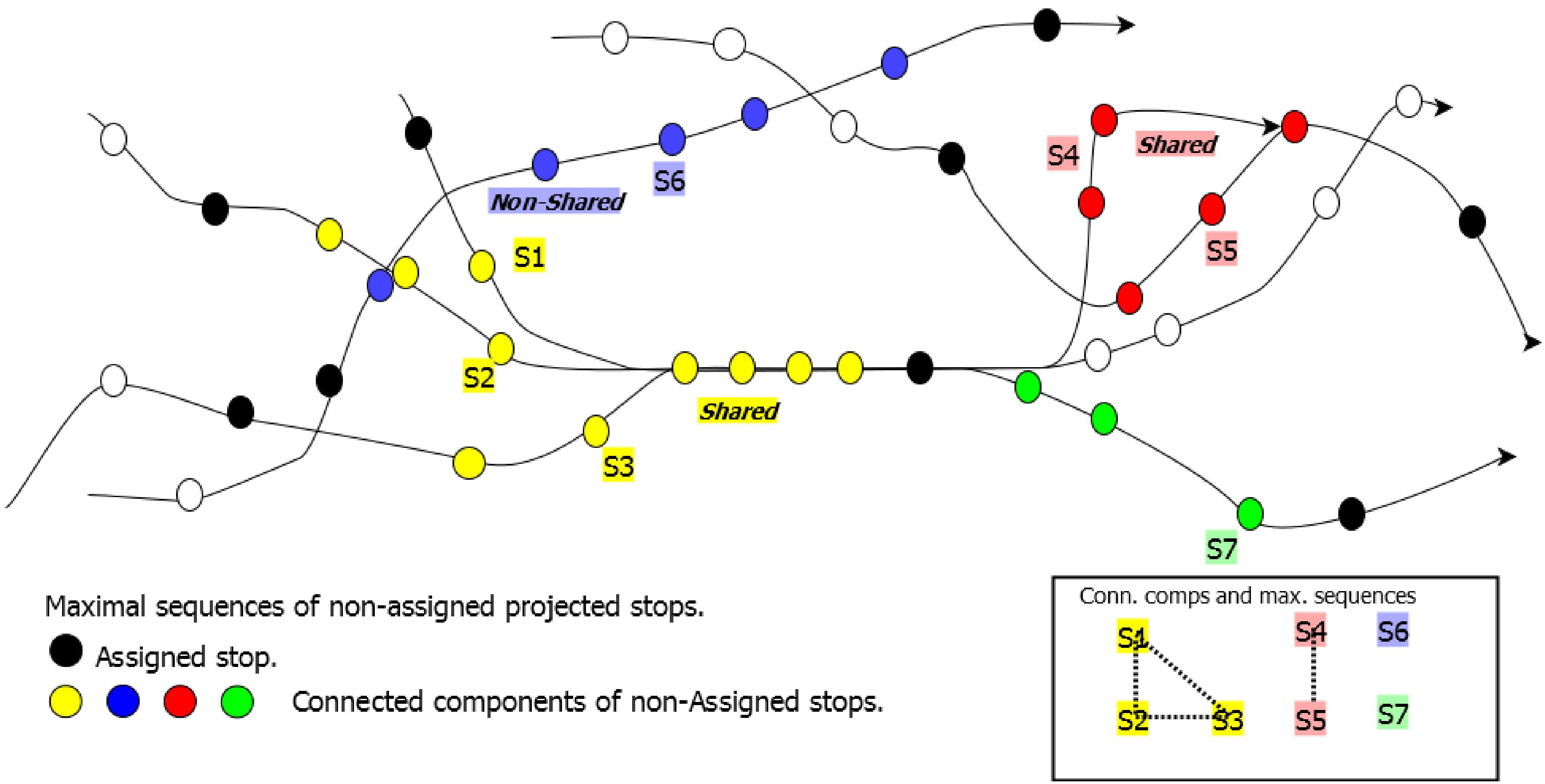
Solution

- Step 6: Assign ambiguous shared GTFS stops
  - For each GTFS stop exactly one Projected stop is to be chosen such that
    - For each bus line, a path in the graph is reconstituted
    - The sum of all bus lines their score is minimal



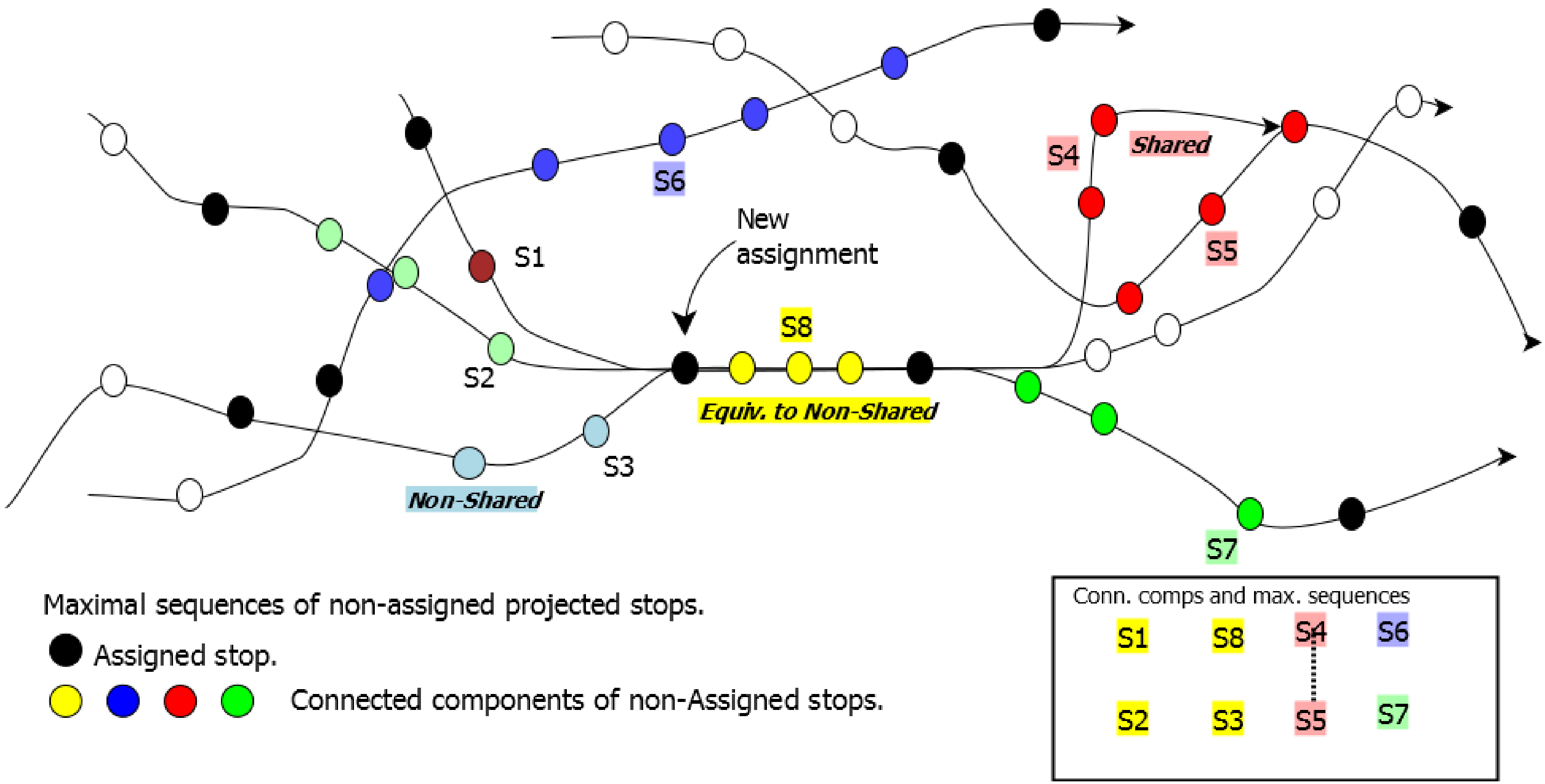
Solution

- Find minimal components for step 5 and step 6



Solution

- Find minimal components for step 5 and step 6



Results

- Started with:
  - 3.783.119 nodes
  - 776.483 roads
- OSM Cleaning:
  - Filtering road types : 164.081 roads removed
  - Resetting incorrect individual values : 0 roads
  - Auto complete data : 136.071 roads
  - Reset incorrect values for related quantities : 571.310 roads
  - Add missing data through rules : all roads
  - Remove links with zero length : 25 links removed
  - Merge GeneralTransportInfrastructures : 72.044 roads merged
  - Merge GeneralLinks : 178.738 links merged
  - Strongly maximum connected subgraph : 24.046 nodes removed
- Ended with:
  - 2.975.568 nodes (Removed 807.551 in total)
  - 537.271 roads (Removed 239.212 in total)

Results

- Step 1: Find projected stops
  - 124.496 projected stops for 31.082 GTFS stops
- Step 2: Reduce candidates
  - 3.141 stops assigned
- Step 3: Create directed graph (projected stops)
- Step 4: Assign unambiguous GTFS stops
  - 19.441 stops assigned
- Step 5: Assign ambiguous non-shared GTFS stops
  - 0 stops assigned
- Step 6: Assign ambiguous shared GTFS stops
  - All the rest (work in progress)

THANKS

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