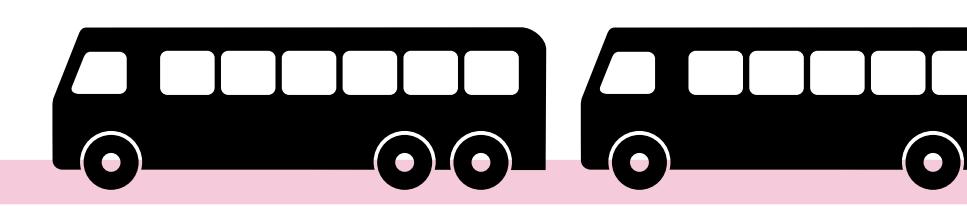


BUS BUNCHING

Aleksandra Palka

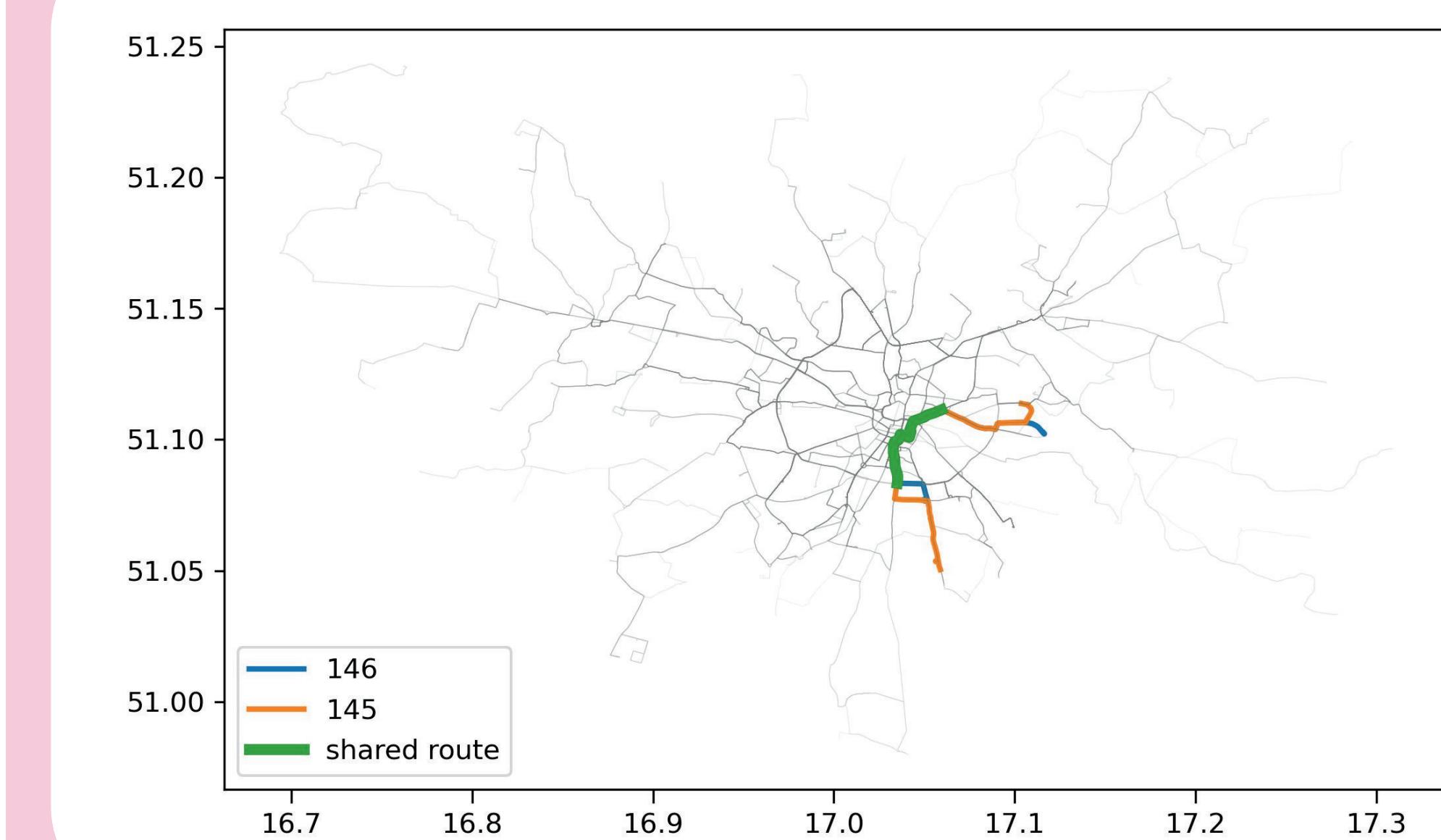


Wrocław Bus Network

Bus bunching is a situation when two or more buses on the same route end up traveling together instead of being evenly spaced out.

How does this happen?

- one bus gets delayed – high traffic, road accidents (or previous one was early)
- because the bus is late, more people are waiting at the next stops
- it takes even longer to pick passengers up
- meanwhile, the bus behind it catches up (it had to pick up less passengers)
- now the buses are “bunched” together



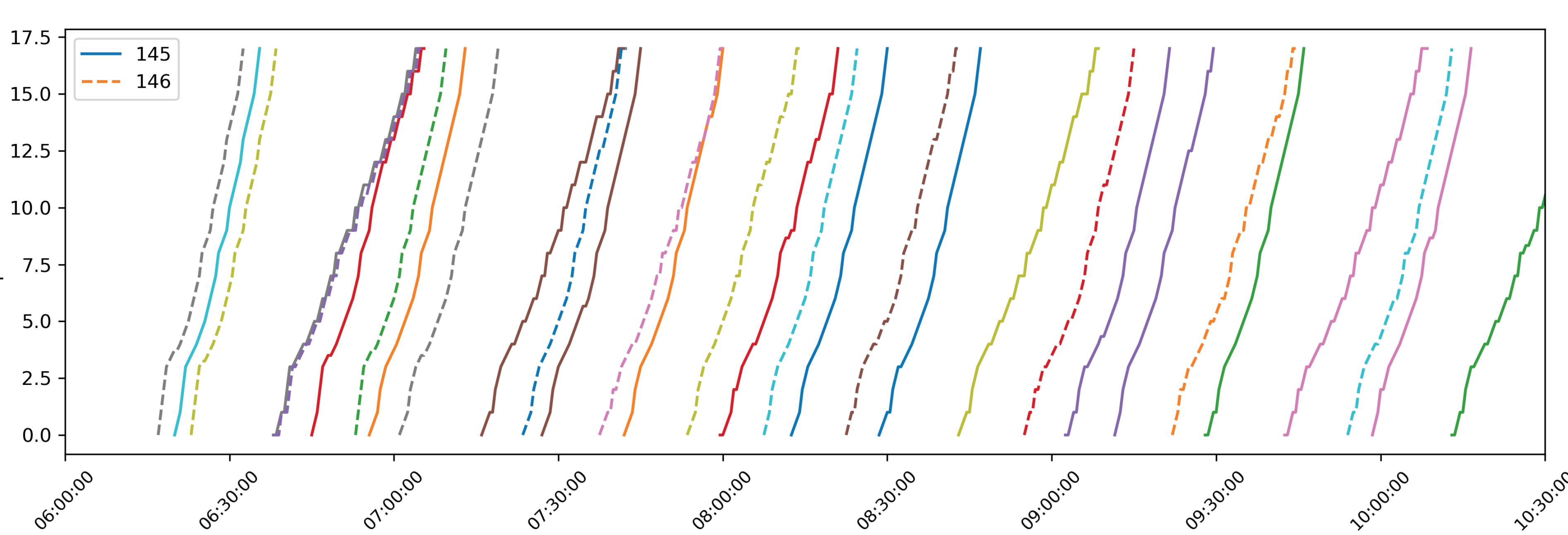
Model of bus network

Buses:

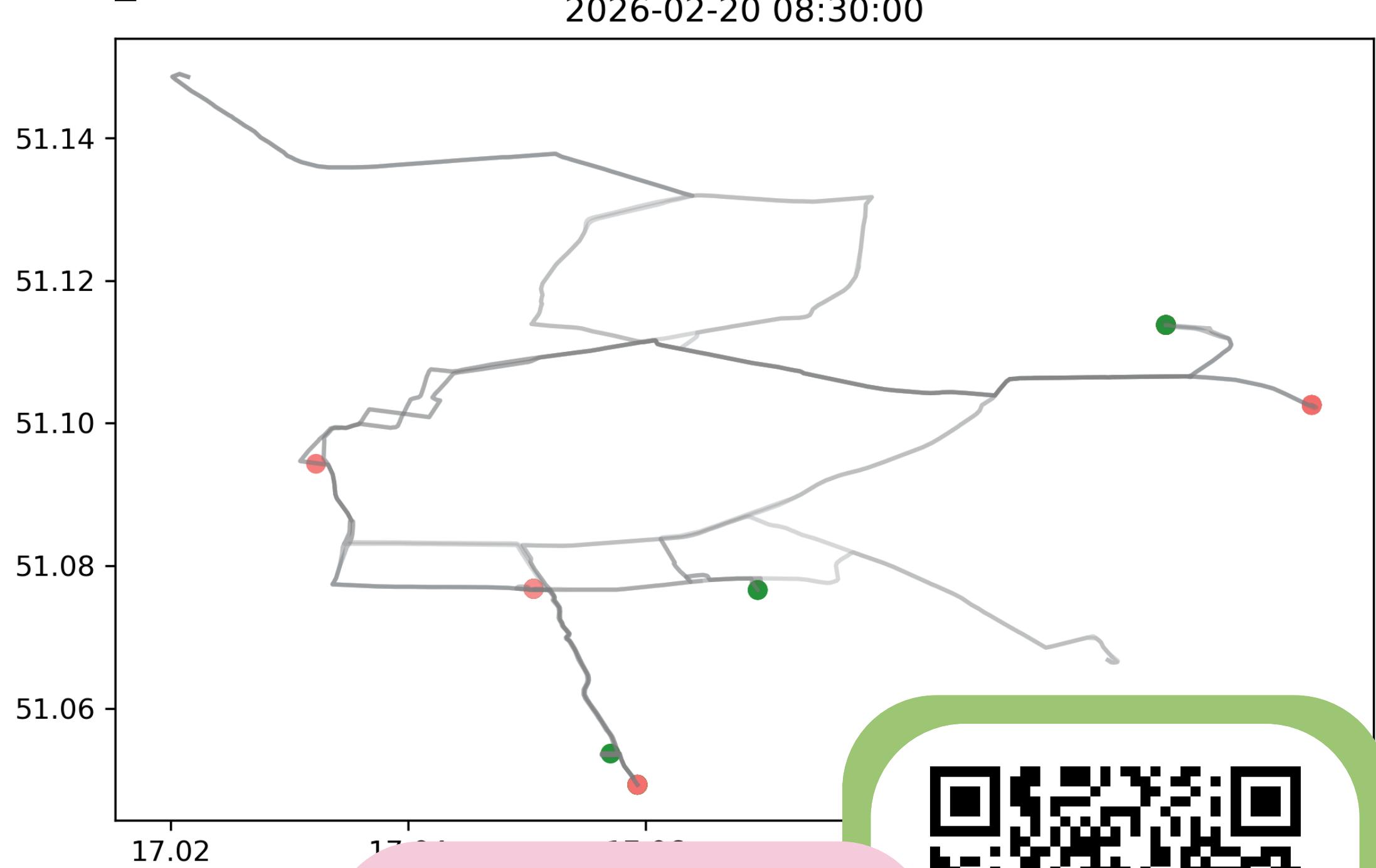
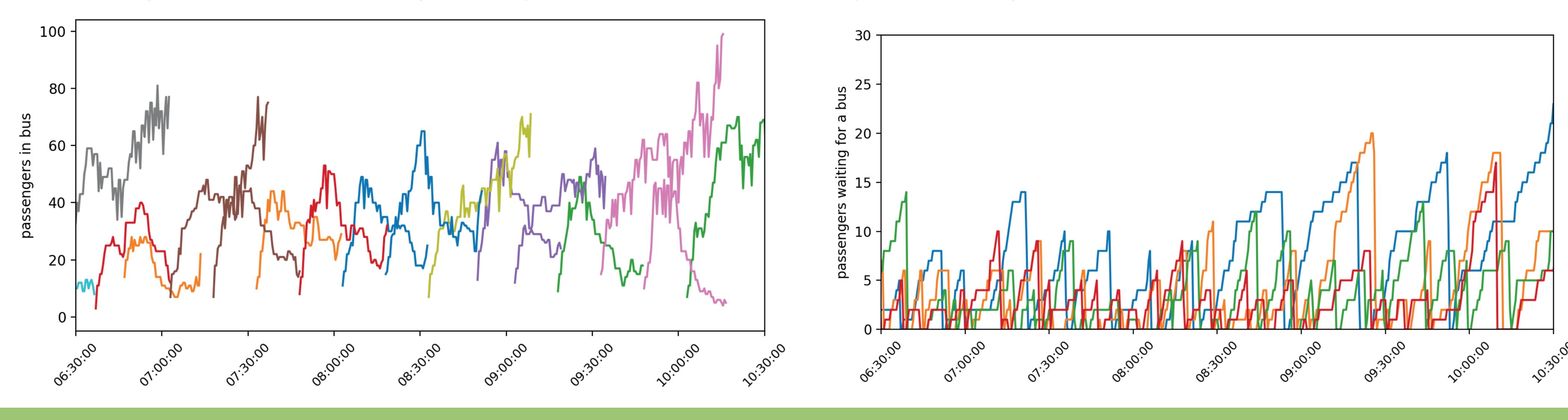
- run according to time table
- have fixed capacity C
- at each timestep with probability (p_{rd}) they can become delayed
- passengers board and unboard the bus with speed v , bus waits until all get on or it is full
- they cannot overtake one another

Passengers:

- arrive at stops randomly, samples taken from Poisson distribution $\mathcal{P}(\lambda)$
- their arrival time does not depend on time table
- at each stop a fraction of passengers disembarks the bus



A single run of simulation shows that bus bunching can occur on these lines in such conditions. Both lines meet quite often in real life similarly as on above plot. Moreover, in rush hours bus of the same lines can meet up as well. A look at passenger in buses and waiting at the stops shows reasonable, realistic results.

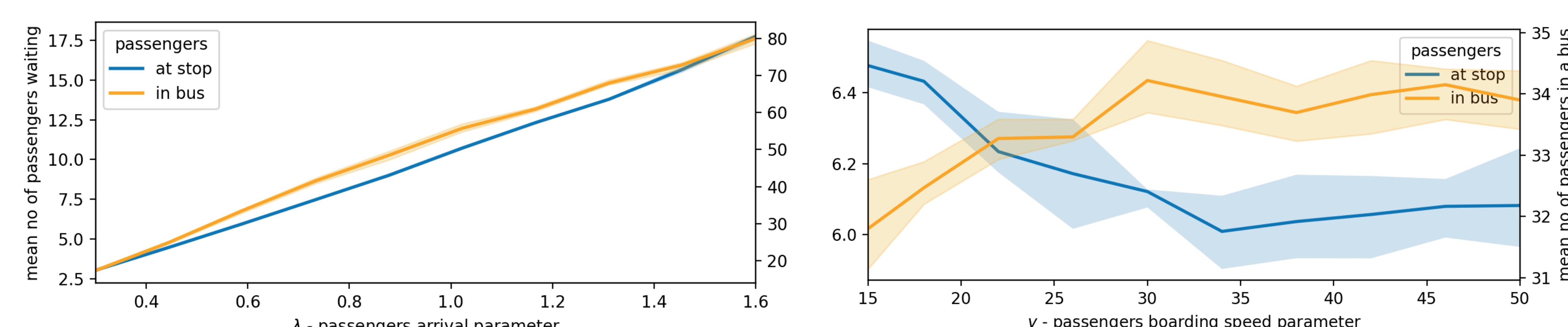
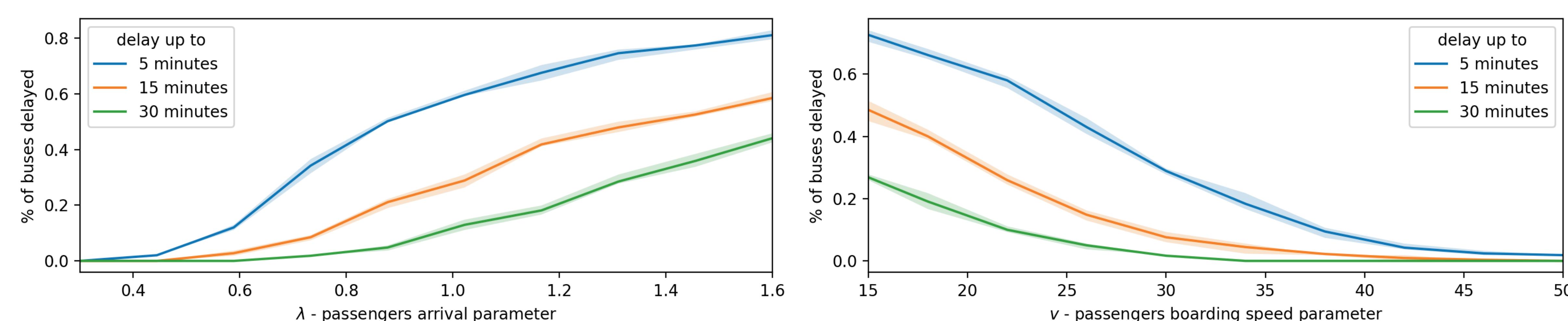


Animation of bus traffic in Wrocław



Some data can be found on how well Wrocław buses stick to schedules. [1] It is said that anywhere from 20%-30% of buses run on delays bigger than 5 minutes. We also know from [2] traffic research in 2024 that average number of people during these simulated hours was 45.

How does choice of v , λ affect buses?



Based on these real results we can try to evaluate which parameters would be based for simulating this bus network. For values from 0.5 to 0.7 can prove useful, while boarding speed might be about 35-40 people per minute. Both of these parameters could be evaluated in real life and used in further development of this simulation.

[1] <https://bip.um.wroc.pl/interpelacja/84714/interpelacja-w-sprawie-spoznajacych-sie-i-wypadajacych-z-rozkladu-kursow-autobusow-mpk-na-osiedlu-pawlownie>
[2] <https://bip.um.wroc.pl/artykul/565/70659/kompleksowe-badania-ruchu-we-wroclawiu-i-otoczeniu-kbr-2024>