Summary of PRT Simulators:

Simulators for Public-use only

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Abstract

Personal Rapid Transit systems, or as known as PRT systems, began to be developed in the mid to late1900's. As people sought for new transportation systems, Housing Urban Development came up with the idea of Personal Rapid Transit systems in 1966. With the mathematical foundation for the new transit system, people began to create new technologies to support the system, such as new vehicle designs, air suspension, and linear induction technology. As the idea of PRT system spread, many engineers from France, West Germany, Japan, and United States of America formed their own firms to develop simulators and vehicle designs to produce better products. To calculate the productivity of the system, vast number of parameterization were needed, and list includes total number of passengers, stations, capacitors, vehicles, and seats per vehicle, total length of the guide way, attraction rates, generating rate, waiting time, physical characteristics of vehicles and tracks, and much more. The vast number of parameters to consider led to many more than 30 kinds of simulators from all over the world. Although some have similar functions, the user interface and the outcomes differ from one to another. Furthermore, each simulator demands for different input methods than another. Therefore, I have created summaries of each simulator on how to use the simulator and what one can harvest from the simulator.

Summary of PRT Simulators: Simulators for Public-use only

Since 1966, more than 30 simulators have been created to render environment similar to users' intentions. Unfortunately, most of them do not exist on internet for public use, or they are private programs. Despite the difficulties of finding working PRT simulators, I have found a few simulators that will be helpful of optimization of a PRT system and are in working conditions. Hermes PRT, RUF, PRTsim (by Logistic centrum), BeamED, NETSIMMODD, PTV VISUM, and PTV VISSIM are the obtainable simulators at this moment, and they seem to be useful for obtaining calculations to optimize the personal rapid transit system user's desiring to make. From the list above, I was able to obtain the following programs, Hermes PRT, RUF, BeamED, PTV VISUM, and PTV VISSIM. In the following paragraphs, I will be explaining how to obtain and install the program, which constants user can parameterize, and what the user will receive as the result of the simulation.

Even though there are lists of PRT simulators and websites explaining each one of them, not all of them are available for public use at the moment. In addition, the websites that explain what the simulators can do either do not have many simulators that actually work, or they are not in detail. The websites which list the PRT simulators are, but not limited to:

- http://faculty.washington.edu/jbs/itrans/simu.htm
- http://www.prtnz.com/publications-mainmenu-37/doc_download/24-some-history-of-prt-simulation-programs.
- http://www.advancedtransit.net/atrawiki/index.php?title=PRT_Simulators

The first link of the three has many different explanations on each simulators made since 1960's, but the explanations are not thorough enough for one to actually start using the simulator.

Despite the second link's thorough explanations of PRT simulators developed since 1969, explanations for simulators from 1990's to now are referred to the first link of the list above. For this reason, I have created summaries for the PRT simulators that are available for public use, are in working conditions, and are free.

Hermes PRT

Installation

Hermes PRT Simulator is open for public use and has been maintained by the creator Christos Xithalis until 2010. One may download the simulator from the website sited above; to run the program, one must have or download Java Runtime Environment 1.5 or higher. After installing the JRE 1.5+, one may proceed to using the program by clicking the file "run," after unzipping the file

Navigation and Customization

To move your map or your point of view in general within the program, one must use drag the right-click button, and use the scroll wheel to zoom in or out Furthermore, one may create stations, capacitors, tracks, intersections, and more to mimic the desired environment and upload a map in the background for higher accuracy.

Inputs for the Simulator

One may also parameterize the following constants:

- Vehicles' physical appearance (Just the appearance, therefore not affecting the result)
- Line colors and slots

- Background (can switch from having a map in the background to having a black background)
- Slot size
- Trip class (affects how many people will actually ride the PRT depending on the distance the group is traveling)
- Generating cells (number of groups "produced" per hour. The default numbers' average is 5 groups/hour)
- Attraction rate (How often groups choose the place as their destination)
- Pause/Fast Forward Time
- Collect statistics during certain time period
- Set group flow between two stations individually
- Set time for the Time Graph (Approximates the time one may take to travel from point A to point B)

Outputs from the Simulator

Furthermore, one receives following data:

- Lengths of the guide ways, both offline and online
- Distance travelled by vehicles, both empty and loaded
- Information on capacitors (Average time spent for empty vehicles to go to/return from capacitors, max number of vehicles at a certain capacitor, number of vehicles sent and received at the capacitor)
- Number of vehicles passed per "line"
- Number of stations, vehicles, groups, and the average speed.

- Average time spent to travel for each distance (waiting time, ticketing, walking, etc.)
- Time needed to travel from Point A to Point B
- Number/percentage of trips made for each distance
- Render and see the result of emergency situations

Conclusion

As it being an open source, one may alter many parameters to render an environment similar to the real life situation. Despite its pros for being a free open-source simulator, certain variables cannot be changed, such as being able to change the constants used for the vehicles. Also, the simulation does not consider physical characteristics, such as the curvature and slope of the guide ways, and the actual speed. Furthermore, the emergency mode is not realistic enough to render real life situations. More detailed information on how to operate the simulator is provided in the zip file.

Figure1.1

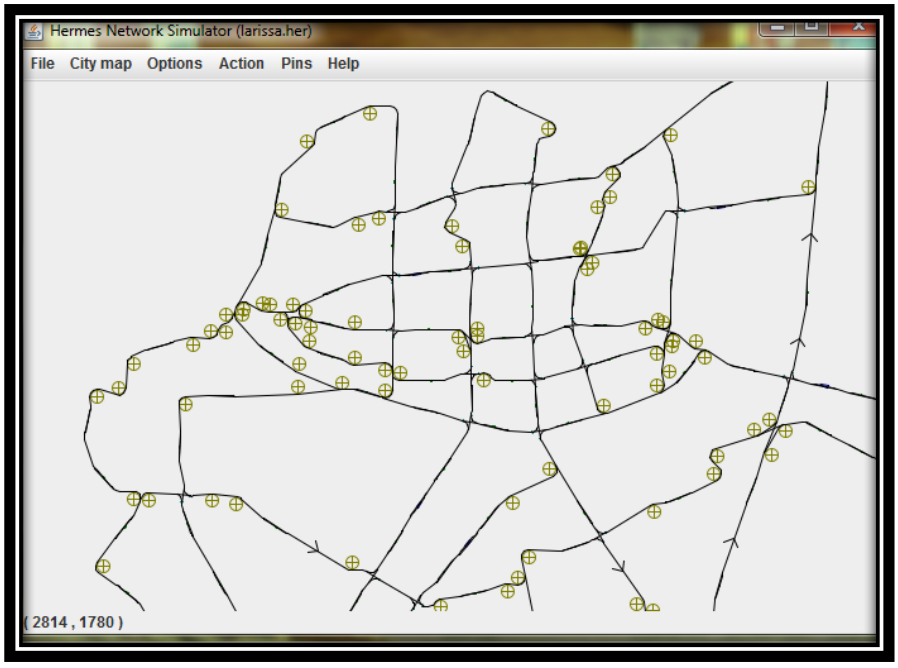


Figure 1.2

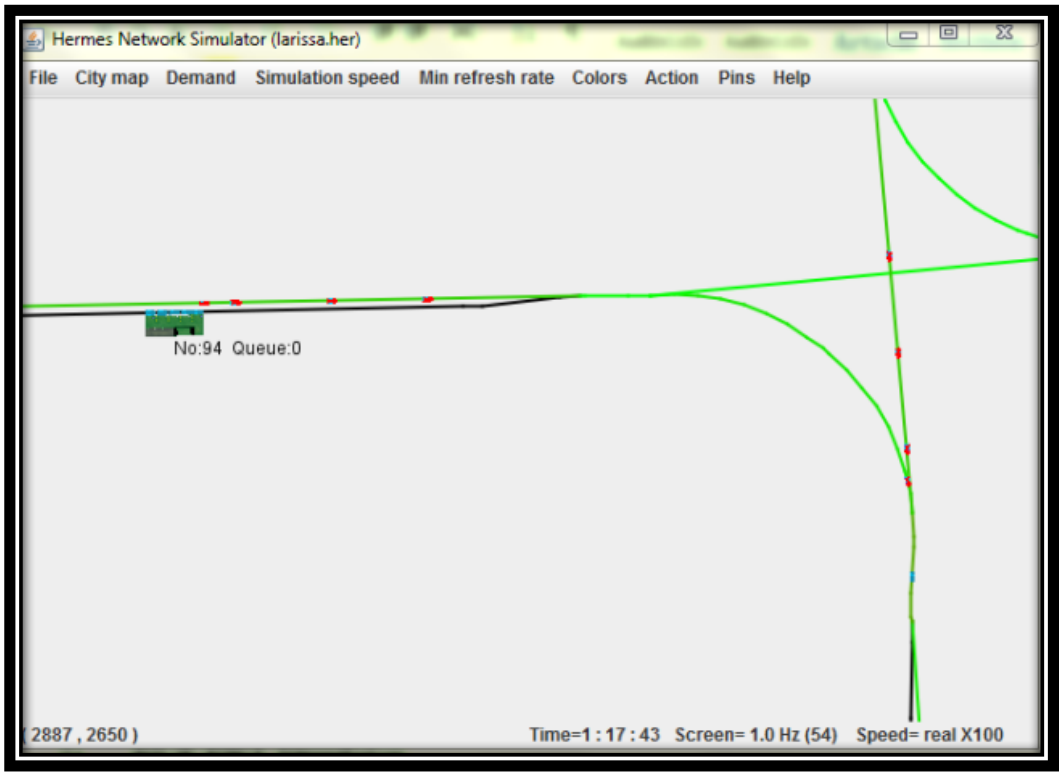


Figure 1.3

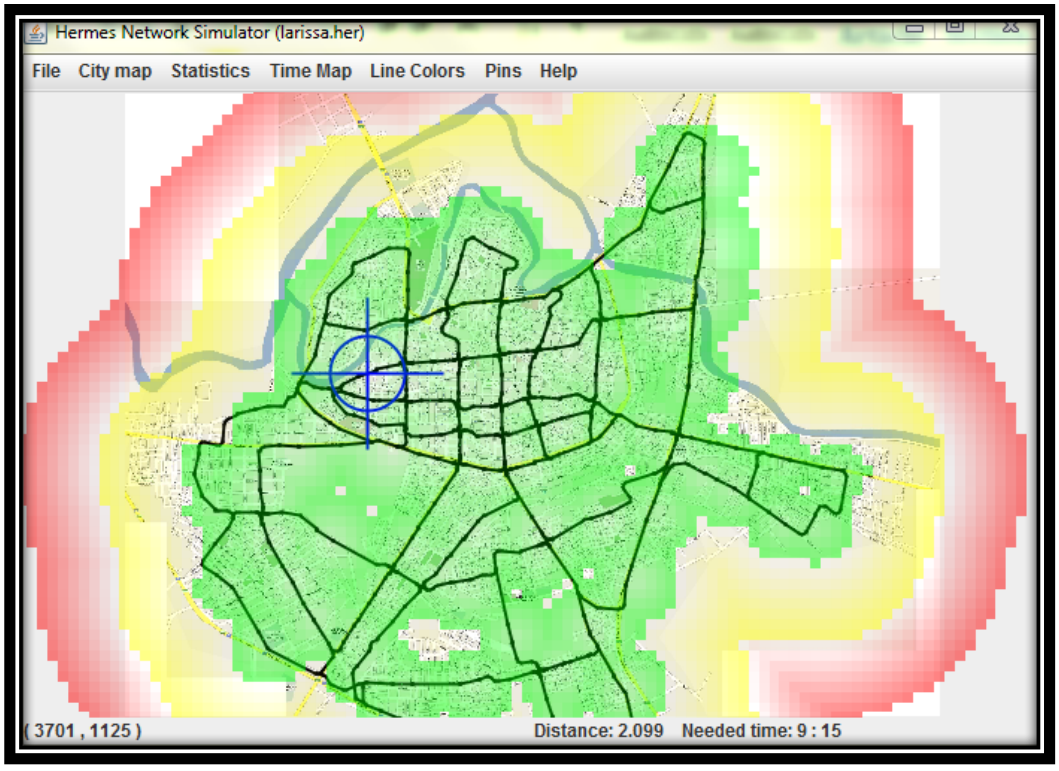


Figure 1.4

General Simulation Statistics

Simulation info		
Simulation run at	Mon Aug 11 00:10:30 PDT 2014	
Network filename	larissa.her	
Demand program filename	no file	
Guideway lengths		
Total guideway length (main lines)(meters)	78855	
Online guideway (meters)	62706	79% of total
Offline guideway (meters)	16149	21% of total
Vehicle kilometers		
Total distance travelled by vehicles (km)	67742	
Distance travelled by loaded vehicles (km)	60308	89% of total
Distance travelled by empty vehicles (km)	7434	11% of total
Capacitor-Station distances		
Average time from upstream (vehicle source) capacitor (sec)	112	
Average time to downstream (vehicle sink) capacitor (sec)	107	
Max time from upstream (vehicle source) capacitor (sec)	311	
Max time to downstream (vehicle sink) capacitor (sec)	329	
General		
Speed	18.0	m/s
Headway	0.3	sec
Number of stations	101	
Number of capacitors	8	
Number of vehicles used during simulation	855	
Number of groups that the system failed to service (due to delays)	0	
Number of waveoff vehicles with passengers	0	
Simulation time (sec)	4663	
Synchronous control related		
Smallest loop (slots)	165	
Max Acceleration during cruise needed (m/sec2)	2.461	slip back capabili

RUF PRT Simulator

The Simulators

RUF International's five different simulators simulate five different environments. Despite the different purposes for each simulator, the simulators are customized to be only used for RUF personal rapid transit system.

RUFcom

One of them, called, "RUFcom" simulates shortest path within the RUF Network in Copenhagen. Although you have options to input the number of commuters, two junctions of

your choice, and look at the flow graphics, the fact that it is only meant for the RUF network at Copenhagen makes it useless for other PRT systems.

RUFcph and RUFla

Another programs called, “RUFcph” and “RUFla” calculate the travel time, length and the energy used within the RUF Network of Copenhagen and Los Angeles. Despite the feature, which allows you to set constants for speed, junction delay, and such, this is only for RUF Network.

RUFsim

A different program called “RUFsim” simulates distribution of spaces among merging vehicles and of different vehicles among the guide ways.

RUFtrain

The last program called “RUFtrain” simulates how acceleration and deceleration near the stations affect the flow or the speed of vehicles and how they affect other vehicles in terms of speed.

Figure 2.1

Figure 2.2

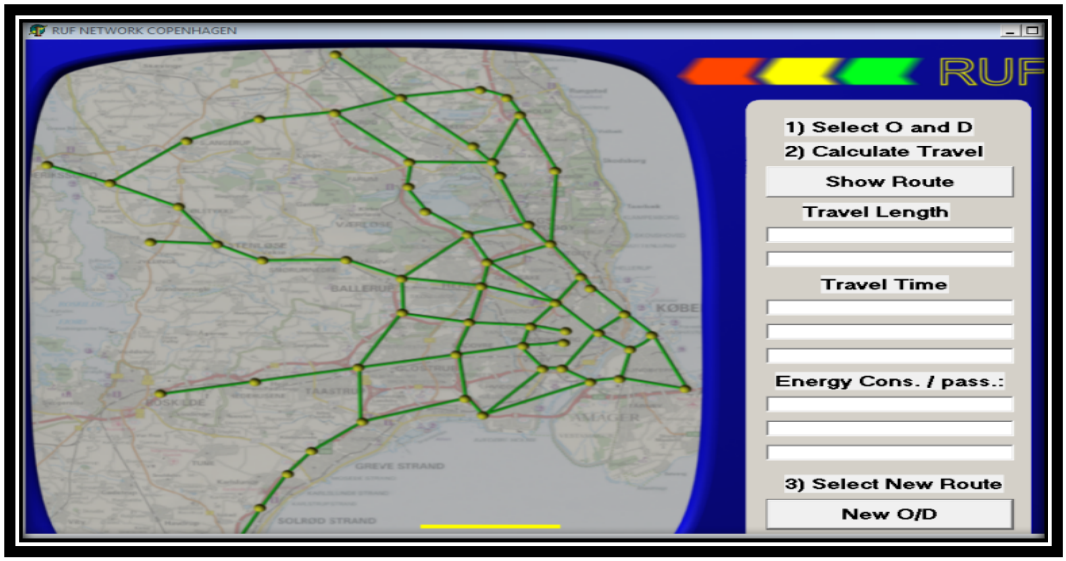
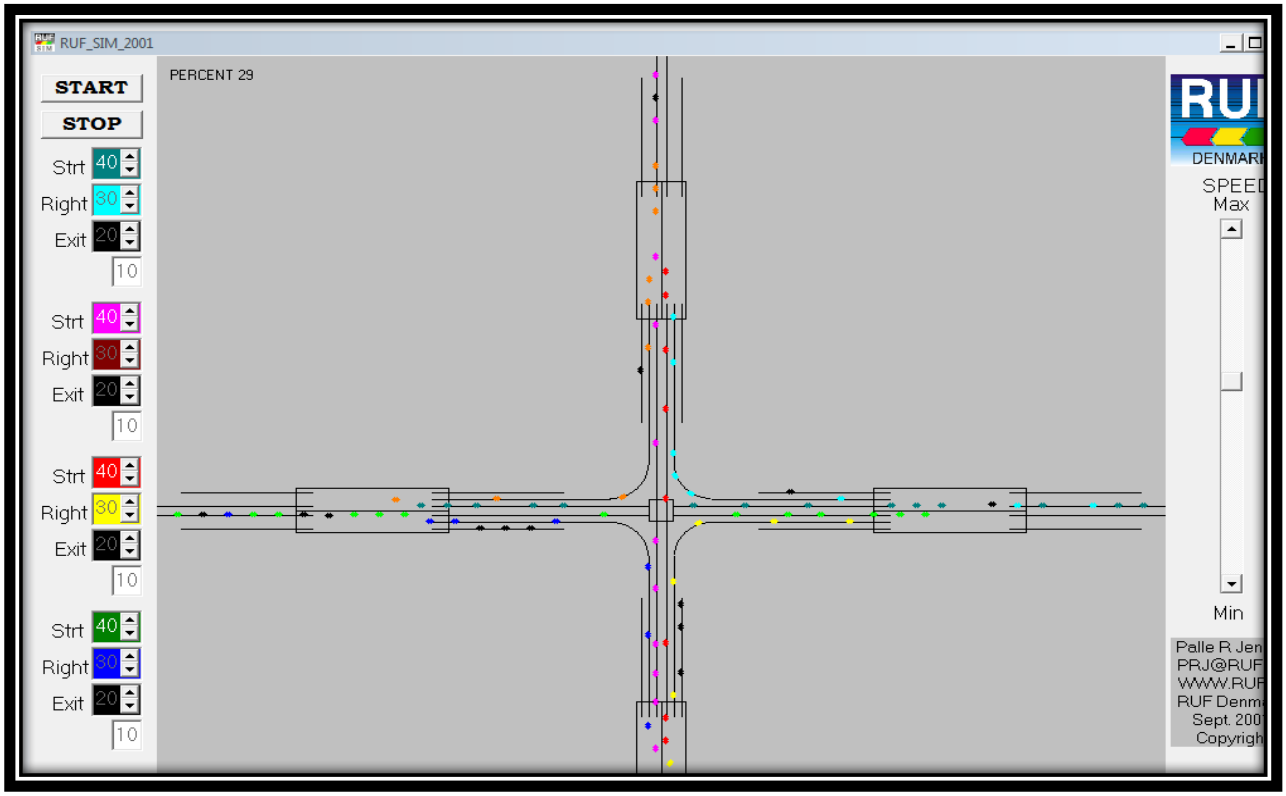


Figure2.3



Conclusion

Although these simulators are useless for this project, the ideas of calculating the energy used/conserved, and the effect of number of vehicles on the guide ways onto congestion, and ability to change constants for speed on the guide ways, junction delay, efficiency of each vehicle, and such must be taken into account when simulating PRT with higher accuracy.

BeamEd

Installation

Beamways's PRT simulator, "BeamEd" is available for public use and it is a closed source program. One may download the PRT simulator BeamEd from Beamways's website and install the program by unzipping the beamd_installer_1_3_3.zip file by following the instructions supplied by the installer.

Instructions for Using the Simulator

After installing the program by following the directions provided by the installer, one may choose to use a map as a background or not, by going to File – Add Map Image and then selecting the maps/pictures you desire to input. After putting the map/image on one's project, one may choose to scale the picture by going to Setup – Image Scale then input the desired values for Xscale and Yscale according to the desired meter per pixel constant. One may also choose the change the reference point, meter position, and the margins. To navigate within the program, one can either use the buttons below File and Edit to either zoom in or out; otherwise, use F2 and F3 to do so. To input stations, one may left-click the spot you desire on the picture and right-click to input depots. One can also connect each stations and depots by clicking the cross at the center of the symbol and then another point of your choice. Furthermore, one can

drag the lines to form curves and connect lines to make 3+ ways. In order to delete or undo what you have done, you may either press Ctrl +Z or put your mouse pointer above the object you want to delete, then press Del or Delete on your keyboard.

Inputs for the Simulator

The following list states constants user can parameterize:

- The Berth length
- Headway
- Seats per vehicle and track spacing
- Total numbers of population, vehicle count, and simulation time
- Velocity, acceleration, jerk, curve acceleration, and curve jerk
- Demand (population percentage per hour)
- Mean group size
- Colors
- Background image/map and the simulation speed

Outputs from the Simulator

After setting up your environment, one can go to Command and click Simulate to get the result. The result includes the following:

- Total length of station and junction ramps and switches
- Total track length
- Weighted total track length
- Added track for ramps and switches

- Number of vehicles
- Number of stations, berths, junctions, 3 ways, and 4 ways
- Number of eligible roundabouts
- Mean trip distance
- Unloaded mean speed
- Population
- Max number of vehicles moving
- Mean speed, full trip length, vehicle distance per trip, and waiting time
- Number of passengers transported, per vehicle, and more

Conclusion

Although the actual simulation is not provided, one can parameterize many constants and render an environment that is similar to author's intention to fulfill one's desire.

Figure3.1

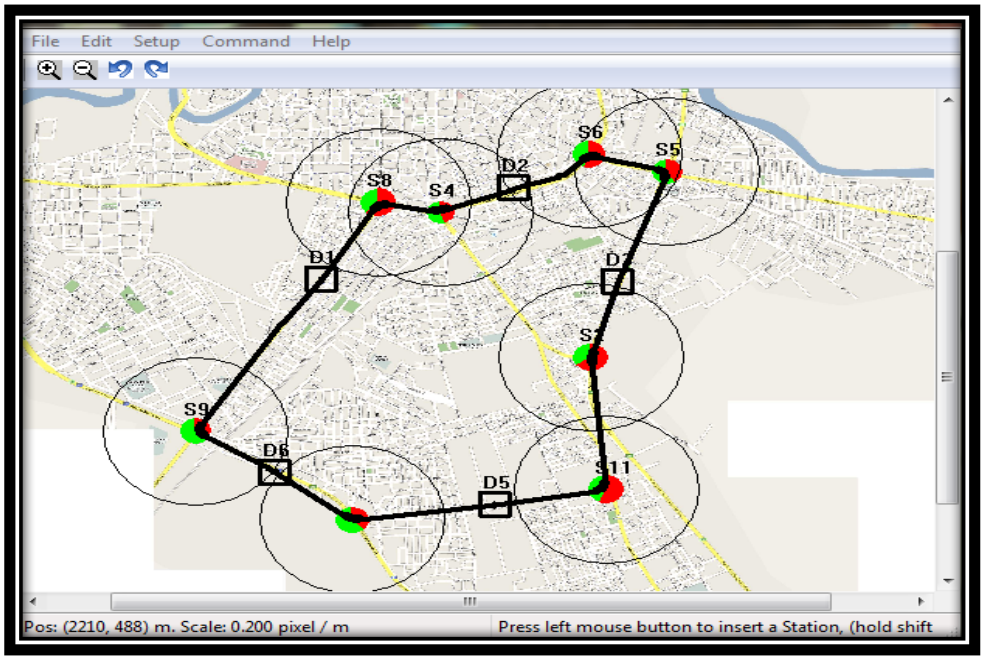
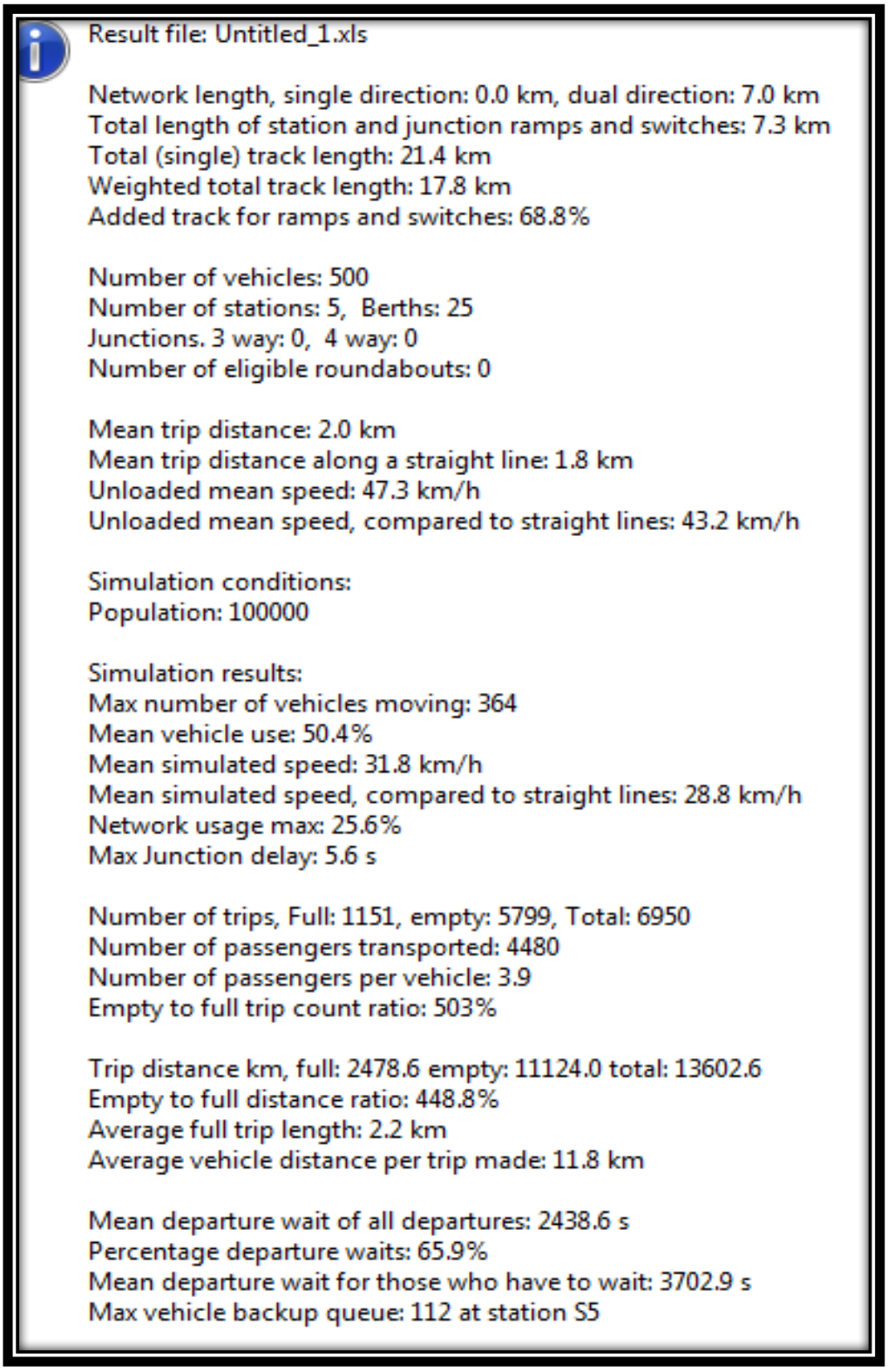


Figure 3.2


Result file: Untitled_1.xls
Network length, single direction: 0.0 km, dual direction: 7.0 km
Total length of station and junction ramps and switches: 7.3 km
Total (single) track length: 21.4 km
Weighted total track length: 17.8 km
Added track for ramps and switches: 68.8%
Number of vehicles: 500
Number of stations: 5, Berths: 25
Junctions. 3 way: 0, 4 way: 0
Number of eligible roundabouts: 0
Mean trip distance: 2.0 km
Mean trip distance along a straight line: 1.8 km
Unloaded mean speed: 47.3 km/h
Unloaded mean speed, compared to straight lines: 43.2 km/h
Simulation conditions:
Population: 100000
Simulation results:
Max number of vehicles moving: 364
Mean vehicle use: 50.4%
Mean simulated speed: 31.8 km/h
Mean simulated speed, compared to straight lines: 28.8 km/h
Network usage max: 25.6%
Max Junction delay: 5.6 s
Number of trips, Full: 1151, empty: 5799, Total: 6950
Number of passengers transported: 4480
Number of passengers per vehicle: 3.9
Empty to full trip count ratio: 503%
Trip distance km, full: 2478.6 empty: 11124.0 total: 13602.6
Empty to full distance ratio: 448.8%
Average full trip length: 2.2 km
Average vehicle distance per trip made: 11.8 km
Mean departure wait of all departures: 2438.6 s
Percentage departure waits: 65.9%
Mean departure wait for those who have to wait: 3702.9 s
Max vehicle backup queue: 112 at station S5

ATS/City Mobile Simulator

Installation

For one to get started, one must download the program first by proceeding to Ultra global Simulator's website. At the website, a link for downloading the exe file with set of instructions for installing and using the program.

Instructions for Using the Simulator

After installing the simulator and opening the file, one will run into the option of choosing a case study. There are three example case studies provided along with an option for creating your own at the top of the window. After opening up a case study, one can build structure by clicking the Build button on the top of the buttons on the left side. By clicking on a space one is intending to put a structure, one will be provided with option to build a station or a vehicle depot. If one chooses to build a station, another options for the name of the station along with the option for choosing the demand of the station. The demand of the station will parameterize number of passengers using that station during the simulation. In addition, by dragging your mouse from a box to another, you can create merges and connect structures. In order to shape the railways, one must click the Edit button below the Build button and drag the lines. By dragging the box of a line, you can move the point far away from the origin, you will be able to adjust the curvature of that part. Furthermore, by left clicking and dragging your mouse to form a box with dotted edges on the map, you can select a group of boxes to keep the segments in the box the same, yet changing the shape of the adjacent railways. Then the user may proceed onto running the simulator.

Inputs for the Simulator

- Design of the PRT network
- Vehicles trips per hour from a station to another
- Appearance of the simulator(colors and sizes of the structures)
- Background image
- Speed of the simulation

Outputs from the Simulator

- Waiting times for each station
- Distance from a station to another
- Trip time

Conclusion

Despite the ease of use, the simulator offers only limited number of parameters, dropping the accuracy of the rendered environment. Furthermore, the outputs from the simulator are not sufficient for one to make corrections to optimize one's personal rapid transit system. Therefore, this simulator may be good for a simple calculation for trip time and waiting time, but not for optimization of a PRT system.

References

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