operators to set up solutions (adding buses on the lines x and y to relieve a given metro line blocked by an incident…) and so as quickly as possible..

Hence, the invention aims at providing a solution to all or part of these problems.

To this end, an aspect of the present invention concerns a method for regulating a transport network, the transport network being used by a plurality of passengers of the network and the transport network comprising at least one transportation mode, each transportation mode of the at least one transportation mode comprising at least one vehicle and a plurality of stations, a start station of the plurality of stations of the at least one transportation mode being connected by a plurality of itineraries, each itinerary of the plurality of itineraries comprising a list of intermediate stations of the plurality of stations, to a destination station of the plurality of stations, a timetable of the at least one transportation mode defining a check-in time of the at least one vehicle at the start station, at the destination station, and at each station of the list of intermediate stations of the itinerary, the plurality of passengers of the network comprising, for each station of the plurality of stations of the at least one transportation mode, a number of passengers waiting at the station, the number of passengers waiting at the station being determined from data captured by at least one data collection instrument, a start-destination matrix defining, for a period of time, and for a pair formed by the start station and the destination station, an additional number of passengers who will come into the network via the start station, over the period of time, to join the destination station,

the method comprising the following steps:

for each transportation mode of the at least one transportation mode,

- determination of a current state of the transportation mode defined for a current time within the period of time;
- simulation of a future state, for a future time, of the transportation mode based on the current state, and of the additional number of passengers who will come into the network over the period of time according to the start-destination matrix;
- assessment of the at least one performance indicator based on the future state of the transportation mode;
- determination of at least one regulatory action on the at least one transportation mode as a function of the assessment of the at least one indicator;
- new simulation of a new future state, for the future time, based on the current state, for the current time, and on the additional number of passengers who will come into the network over the period of time according to the start-destination matrix;
- new simulation of the at least one performance indicator of the transportation mode based on the new future state;

- comparison of the result of the new assessment and of the assessment of the at least one performance indicator;
- repetition of the steps of determination of at least one regulatory action, of new simulation, of new assessment and of comparison until a result of the comparison indicates an improvement of the at least one performance indicator,
- implementation of the at least one regulatory action determined at the last occurrence of the step of determination in order to improve the transport network performance,

the simulation of the future state and the new simulation of the new future state being respectively carried out, for at least one intermediate time between the current time and the future time, by distributing over the plurality of itineraries joining the start station and the destination station, according to a predetermined distribution procedure, the number of passengers waiting at said start station to join said destination station, added to the estimated additional number, for said start station and for a period of time including the at least one intermediate time, based on the start-destination matrix.

According to these arrangements, the top operator of the multimodal transport network can determine the suitable regulatory action(s) to improve at least one performance indicator of the network, in view of the predicted effect of the regulatory action(s).

If the regulatory actions turn out to have a satisfactory predicted effect on the performance indicator(s), then these actions may be implemented by the operator of the multimodal network, so as to effectively improve the performance of the network in accordance with the determined indicators.

According to these arrangements, the method allows assisting the operator of the multimodal network to better plan his multimodal mobility offering to better respond to the dynamic evolution of the mobility streams, thereby allowing improving the overall punctuality of the service, while considering the viewpoint of the passenger (the arrival time rather than the departure/arrival time of the transport vehicle), while enabling the operator to test the impact of regulatory scenarios on the mobility system.

According to one implementation mode, the invention comprises one or more of the following features, considered separately or in combination.

According to one implementation mode, the predetermined distribution procedure is carried out based on a passenger-profile associated to each passenger of the plurality of passengers waiting at said start station, and as a function of an intermediate state of the network defined at the intermediate time.

According to one implementation mode, the passenger-profile associated to each passenger of the plurality of passengers is defined by travel preferences.

According to one implementation mode, the passenger-profiles and the passenger-destinations of the waiting passengers are predetermined for each transportation mode, based on a history of statistical data built from simulations of

CLAIMS

1. A method for regulating a transport network, the transport network being used by a plurality of passengers of the network and the transport network comprising at least one transportation mode, each transportation mode of the at least one transportation mode comprising at least one vehicle and a plurality of stations, a start station of the plurality of stations of the at least one transportation mode being connected by a plurality of itineraries, each itinerary of the plurality of itineraries comprising a list of intermediate stations of the plurality of stations, to a destination station of the plurality of stations, a timetable of the at least one transportation mode defining a check-in time of the at least one vehicle at the start station, at the destination station, and at each station of the list of intermediate stations of the itinerary, the plurality of passengers of the network comprising, for each station of the plurality of stations of the at least one transportation mode, a number of passengers waiting at the station, the number of passengers waiting at the station being determined from data captured by at least one data collection instrument, a start-destination matrix defining, for a period of time, and for a pair formed by the start station and the destination station, an additional number of passengers who will come into the network via the start station, over the period of time, to join the destination station,

the method comprising the following steps:

for each transportation mode of the at least one transportation mode,

- determination of a current state of the transportation mode defined for a current time within the period of time;
- simulation of a future state, for a future time, of the transportation mode based on the current state, and of the additional number of passengers who will come into the network over the period of time according to the start-destination matrix;
- assessment of at least one performance indicator based on the future state of the transportation mode;
- determination of at least one regulatory action on the at least one transportation mode as a function of the assessment of the at least one indicator;
- new simulation of a new future state, for the future time, based on the current state, for the current time, and on the additional number of passengers who will come into the network over the period of time according to the start-destination matrix;
- new simulation of the at least one performance indicator of the transportation mode based on the new future state;
- comparison of the result of the new assessment and of the assessment of the at least one performance indicator;

- repetition of the steps of determination of at least one regulatory action, of new simulation, of new assessment and of comparison until a result of the comparison indicates an improvement of the at least one performance indicator,

- implementation of the at least one regulatory action determined at the last occurrence of the step of determination in order to improve the transport network performance,

the simulation of the future state and the new simulation of the new future state being respectively carried out, for at least one intermediate time between the current time and the future time, by distributing over the plurality of itineraries joining the start station and the destination station, according to a predetermined distribution procedure, the number of passengers waiting at said start station to join said destination station, added to the estimated additional number, for said start station and for a period of time including the at least one intermediate time, based on the start-destination matrix.

2. The regulation method according to claim 1, wherein the predetermined distribution procedure is carried out based on a passenger-profile associated to each passenger of the plurality of passengers waiting at said start station, and as a function of an intermediate state of the network defined at the intermediate time.

3. The regulation method according to claim 2, wherein a passenger-itinerary is associated to each passenger of the plurality of passengers waiting at said start station, the passenger-itinerary being determined as a function of the passenger-profile.

4. The regulation method according to any of claims 1 to 3, wherein the predetermined distribution procedure is a multimodal dynamic assignment procedure.

5. The regulation method according to any of the preceding claims, wherein the at least one data collection instrument is a sensor, or a statistical data learning application, or a remote tickets purchase ticketing application.

6. The regulation method according to any of the preceding claims, wherein the current state of the transportation mode is defined by at least one parameter, the at least one parameter comprising one amongst:

- a number of passengers waiting at the stations of the plurality of stations of the transportation mode,

- a position and a load of the at least one vehicle of the transportation mode,

- a distribution by passenger-profile, of the number of passengers waiting at the stations of the plurality of stations of the transportation mode,

and wherein a value is determined by the at least one data collection instrument, or estimated, for each parameter of the at least one parameter, at the determination step.

7. The regulation method according to claim 6, wherein the passenger-itinerary comprises a list of stations, each station of said list being a station of the plurality of stations of the at least one transportation mode, and each station of said list being determined as a function of the check-in time of the at least one vehicle of each transportation mode of the at least one transportation mode at the stations of the plurality of stations of each transportation mode of the at least one transportation mode, and so as to optimize the check-in time at the passenger-destination, and as a function of the passenger-profile.

8. The regulation method according to any of the preceding claims, wherein the at least one transportation mode comprises at least one of the transportation modes amongst the transportation modes: by road, by rail, by air, by inland waterways, by sea.

9. The regulation method according to any of the preceding claims, wherein the at least one performance indicator of the transportation network comprises at least one of the indicators: punctuality, regularity, occupancy rate, waiting time, trip duration.

10. The regulation method according to any of the preceding claims,

- wherein the at least one regulatory action of the transportation mode comprises at least one of the actions amongst:
  - add a vehicle,
  - modify an itinerary of a vehicle to go from one station of the plurality of stations to another station of the plurality of stations of the transportation mode,
  - modify a check-in time of the at least one vehicle at a station of the plurality of stations,
  - close a station for a while,
  - set up a replacement bus,
  - close a section for a while,
  - reduce the rate,
  - add a station, and
  - delete a stop.

11. The regulation method according to any of the preceding claims, wherein the simulation of the future state and the new simulation of the new future state is carried out based on a vehicle-itinerary and on a vehicle-behavior model of the at least one vehicle,

and wherein the vehicle-behavior model of the at least one vehicle is defined by a plurality of vehicle-states of the at least one vehicle and by at least one vehicle-state

change rule to make the at least one vehicle switch from an initial vehicle-state into a next vehicle-state of the plurality of vehicle-states of the at least one vehicle,

and wherein the vehicle-itinerary of the at least one vehicle comprises a subset of stations of the plurality of stations of the transportation mode of the at least one transportation mode, the subset of stations comprising a departure station, intermediate stations, a terminus station and, optionally, at least one intermediate itinerary to go from one station of the subset of stations to the station.

12. The regulation method according to claim 11,

wherein the plurality of vehicle-states of the at least one vehicle comprises one of the vehicle-states amongst:

- vehicle at stop by a signal,
- vehicle moving,
- vehicle at stop by a station,
- vehicle being loaded,
- vehicle being closed,
- vehicle arrived at the terminus,

and wherein the at least one vehicle-state change rule of the at least one vehicle comprises at least one safety rule and at least one rule for determining a displacement speed.

13. The regulation method according to any of the preceding claims, wherein the simulation of the future state and the new simulation of the new future state is carried out based on a passenger-behavior model of the plurality of passengers of the transportation mode,

the passenger-behavior model of the plurality of passengers being defined by a plurality of passenger-states of the at least one passenger and by at least one passenger-state change rule for making the at least one passenger switch from an initial state into a next state of the plurality of passenger-states of the plurality of passengers.

14. The regulation method according to claim 13, wherein the transport network comprises at least one connection between a transportation mode and another transportation mode of the at least one transportation mode, the connection being defined by a connection station of the plurality of stations of the transportation mode of the at least one transportation mode, towards another connection station of the plurality of stations of the other transportation mode of the at least one transportation mode,

and wherein the plurality of passenger-states of the at least one passenger comprises one of the passenger-states amongst:

- waiting at station,

- onboard,
- walking in transit,
- boarding,
- descending,
- arrived at destination,

and wherein, optionally, the at least one passenger-state change rule of the at least one passenger comprises at least one walking speed determination rule conditioned by the passenger-profile of the at least one passenger.