CLAIMS

What is claimed is:

~~1. A method enabling according to predetermined procedure to perform by in-vehicle apparatus privileged tolling transaction with a toll charging center, while non-exposing trip details, and transmitting position related data to a path control system, the method comprising:~~

~~**a.** Receiving by an in-vehicle apparatus data associated with time related varying positions of a path which should be developed according to dynamic updates to an in-vehicle driving navigation aid,~~

~~**b.** Tracking and storing positions along a trip by said in-vehicle apparatus,~~

~~**c.** Comparing by said in-vehicle apparatus said tracked time related positions by the in-vehicle apparatus with time related positions associated with said path that should be developed according to updates to the driving navigation aid,~~

~~**d.** Determining by said in-vehicle apparatus, according to a level of a match, privilege related toll charging data,~~

~~**e.** Transmitting by said in-vehicle apparatus using an IP address associated with the in-vehicle apparatus a message which is characterized by being vehicle identifying and not trip identifying toll charging related data message, wherein the IP address differs from an IP address that is associated with the in-vehicle apparatus while in-vehicle positioning related data is transmitted anonymously.~~

~~2. An in-vehicle apparatus which according to 1 comprises:~~

~~**a.** Mobile internet transceiver,~~

~~**b.** GNSS positioning receiver,~~

~~**c.** Processor and memory,~~

~~**d.** Communication apparatus to communicate with an in-vehicle driving navigation aid.~~

~~3. A method and a system according to which conditions to improve traffic flow on a road network is encouraged by encouraging directly or indirectly usage of vehicles having in-vehicle driving navigation aids which interact with drivers, or with driving control means of autonomous-vehicles, to guide trips of a vehicles according to path-controlled trips, the method comprises:~~

~~a) receiving by an in-vehicle driving navigation aid data for dynamic path assignments,~~

~~b) tracking by in-vehicle apparatus the actual path of the trip,~~

~~c) comparing by in-vehicle apparatus the tracked path with the path complying with the dynamic path assignments along a trip,~~

~~d) determining by in-vehicle apparatus the privilege entitling usage of the assigned path according to predetermined criteria for the level of the match determined by the comparison.~~

~~e) transmitting by in-vehicle apparatus privilege related transaction data which expose no trip details.~~

4. A method and a system according to which traffic flow improvement conditions on a road network is encouraged by encouraging directly or indirectly usage of vehicles having in-vehicle driving navigation aids which interact with drivers, or with driving control means of autonomous vehicles, to guide trips of a vehicles according to path controlled trips, the method comprises:

a) receiving by an in-vehicle driving navigation aid data for dynamic path assignments,

b) tracking by in-vehicle apparatus the actual path of the trip,

c) comparing by in-vehicle apparatus the tracked path with the assigned path complying with the dynamic path assignments along a trip,

d) determining by in-vehicle apparatus the privilege entitling usage of the assigned path according to predetermined criteria for the level of the match determined by the comparison.

5. A method according to 3 or 4, wherein said privilege is free of charge road toll.

6. A method according to 3 or 4, wherein said privilege is discount in charged road toll.

7. A method according to 5 or 6, wherein an entitlement for privilege include a criterion according to which travel on certain predetermined links requires that a trip will be stopped for a minimum predetermined time.

8. A method according to 7, wherein said predetermined links are links on which traffic is diluted.

9. A method according to 3 or 4, wherein a said vehicle is an autonomous vehicle classified as level 4 according to the Society of Automotive Engineers.

10. A method according to 3 or 4, wherein a said vehicle is an autonomous vehicle classified as level 5 according to the Society of Automotive Engineers.

11 A method according to 3 or 4, wherein path controlled trips tending to be coordinated by dynamic assignment of paths performed by coordinating path control.

12. A method according to 11 wherein which traffic on the network tends to converge to traffic load balance.

13. A method according to 11, wherein a DTA simulator is used with traffic predictions of coordinating path control.

14. A method according to 13, wherein the DTA simulator includes models of motion of autonomous vehicles on roads and interactions of autonomous vehicles with other vehicles on roads.

15. A method according to 11, wherein gradual coordination is applied by determining current highest priority links which negatively contribute to traffic load balance subject to a given computation power.

16. A method according to 11, wherein dynamic assignments of paths use processes of coordination control iterations.

17. A method according to 16, wherein coordination control iterations apply fairness related processes.

18. A method according to 17, wherein processes of iterations of coordination control are also used.

19. A method according to 12,13,14,16, 17 and 18, wherein, paths are assigned to fictitious destinations on a fictitious road map which expands a real part of a road map with evacuation of traffic from a part of a network.

20. A method according to 12, 13, 14, 16, 17 and 18, wherein, paths are assigned to fictitious destinations on a fictitious road map which expands a real part of a road map with traffic dilution of a part of a network.

21. A method and system according to which improved safe driving on a road network is encouraged by encouraging usage of safety aids, the method comprises:

a) tracking by in-vehicle apparatus the actual use of said safety aid along the trip,

d) determining by in-vehicle apparatus privilege related data for usage of said safety aid according to predetermined criteria entitling privilege for the level usage,

c) transmitting by in-vehicle apparatus privilege related transaction data which expose no trip details.

22. A method according to 21, wherein said privilege applies free of charge road toll.

23. A method according to 21, wherein said privilege is a discount in charged road toll.

24. A method according to 21, wherein safety aids are cooperative safety driving aids enabling to improve a single in-vehicle measurement of a safety driving aid by in-vehicle fusion of the measurement with one or more respective measurements performed by other one or more vehicles and received by a fusion apparatus through vehicle to vehicle communication.

25. A method according to 3,4 and 21, wherein privilege for usage refers to usage of both safety driving aids and path controlled trips.

26. A method according to which a path control system assigns paths to path controlled trips according to coordination control processes, wherein coordination control processes comprise iterative mitigation processes, and wherein an iteration of mitigation processes comprise determination of relatively loaded links, and wherein determination of relatively loaded links is associated with processes to determine time dependent traffic volumes to capacity ratios related data on network links along predicted time horizon which include feeding a calibrated Dynamic Traffic assignment (DTA) simulation by:

a. non-mitigated pending paths,

b. current and predicted assigned paths associated with path controlled trips, which are not associated with non mitigated pending paths.

27. A method according to 26, wherein paths fed to the DTA simulation include current and predicted non path controlled trips.

28. A method according to 26, wherein paths fed to the DTA simulation include current and predicted non coordinating path controlled trips.

29. A method according to 26, wherein determination of relatively loaded links further include determination of reference time dependent traffic volume to capacity ratios related data which include feeding a calibrated Dynamic Traffic assignment (DTA) simulation by:

a. current and predicted assigned paths associated with path controlled trips,

b. current and predicted non path controlled trips.

30. A method according to 29, wherein paths fed to the DTA simulation include current and predicted non coordinating path controlled trips.

31. A method according to 26, wherein an iteration of mitigation processes includes searching for new alternative paths to yet non mitigated pending alternative paths, preferably by substantially simultaneous search processes, wherein time dependent travel times that are associated with a search are determined by synthesis of DTA based traffic prediction fed by paths which include current and predicted assigned paths associated with path controlled trips which include paths that are associated with mitigated paths up to the current iteration in current cycle,

32. A method according to 31, wherein paths fed to the DTA simulation include current and predicted non path controlled trips.

33. A method according to 31, wherein paths fed to the DTA simulation include current and predicted non coordinating path controlled trips.

34. A method according to 31, wherein an iteration of mitigation processes includes:

a. Determining a threshold related acceptance criterion to accept new alternative paths as a substitution to assigned path controlled trips, wherein the threshold is adaptively determined in order to enable controllable mitigation by the current iteration in perspective of one or more prior iterations,

b. Accepting new alternative paths or pending alternative paths according to a predetermined acceptance procedure which may but not be limited to a threshold which enables to put a limit on acceptance of said new alternative paths, according to results from said search.

35. A method according to 34, wherein a threshold puts a limit on the maximum accepted reduction in potential travel time improvement in comparison to the potential travel time improvement that was assumed to be gained by said search for a path which became a non mitigated pending path.

36. An apparatus comprising means for performing the method of any one of claims 1 and 3-35.

CLAIMS

What is claimed is

1. A method to generate conditions enabling to apply predictive traffic load balancing on a road network, the method comprising:

transmitting from a vehicle its position and destination to get served as an incentivized path-controlled trip by a navigation control system, and receiving a path for a path-controlled trip, wherein transmission of said position and destination and reception of said path use anonymous vehicle IP addressing, and wherein incentivized path controlled-trips are entitled with privileged network usage of free of charge toll or toll discount for obedience to the navigation control system applying, through path controlled trips, predictive traffic-load-balancing on at least a regional part of a city road network;

receiving at the vehicle path updates from the navigation control system and transmitting from the vehicle position updates to the navigation control system, wherein reception of the path updates and transmission of the position updates use anonymous vehicle IP addressing;

determining, under in-vehicle control, one or more charging amounts related to the vehicle's network-usage, comprising:

tracking positions of the vehicle and determining matches and mismatches of tracked positions with positions that could acceptably be developed by the vehicle according to received path updates; and

determining at least one charging amount related to network-usage for one or more matches according to data determining privileged network usage cost, and a charging amount related to network-usage for one or more determined mismatches according to data determining non-privileged network usage cost, wherein privilege in network usage is configured to enable simulation-based traffic predictions, associated with model predictive control supporting planning of paths for said predictive traffic load balancing, to be independent of modeling non path-controlled trips; and

transmitting from the vehicle charging related data, associating a charging related ID with at least one charging amount related to the vehicle's network-usage, according to a charging

procedure allowed to expose a non-anonymous ID with charged network usage associated with a path-controlled trip.

2. The method of claim 1, wherein a transmission associated with charging related data and related transmissions associated with position updates from the vehicle include no common information enabling unique association of charging related data with related positions of a path controlled trip, and wherein, subject to usage of common mobile communication medium to transmit from the vehicle non anonymous charging related data and related transmissions of position updates anonymously.

3. The method of claim 1, wherein the navigation system and the charging system are two separate systems.

4. The method of claim 1, wherein entitlement for privileged network usage by a new path-controlled trip, after arrival to a destination of a previous path-controlled trip on a non-preferred link for load-balancing, is subject to a predetermined waiting time at the destination of the previous path-controlled trip, wherein said non-preferred link is associated with the regional part of the city road network.

5. The method of claim 1 comprising storing in an in-vehicle memory trip-related information enabling to interrogate a potential appeal associated with a charged ID on a charged amount.

6. The method of claim 1, wherein determination of privileged network usage for said potential matches is associated further with determination of privileged network usage for autonomous driving.

7. The method of claim 1, wherein a local automatic car plate identification system identifies vehicles on the network and a vehicle associated with a path-controlled trip communicates with a server enabling to confirm usage of path-controlled trips.

8. The method of claim 1, wherein the model predictive control, associated with the navigation control system, plans paths - for on-network path-controlled trips and for predicted path-controlled trips, enabling path controlled trips to perform predictive traffic-load-balancing on the said at least regional part of the city road network, wherein position updates from vehicles associated with on-network path-controlled trips are used by the navigation control system to update the positions of on-network path controlled trips in the traffic simulator.

9. The method of claim 1, wherein, subject to handling anonymous and non-anonymous transmissions while using active IP addressing through a common communication medium, anonymous vehicle IP address used with transmission of position updates and IP address used with transmission of non-anonymous charging related data are configured to use different vehicle IP addresses.

10. The method of claim 1, wherein planning of paths for path-controlled trips mitigates relatively loaded links using a plurality of phases of re-planning, and wherein a phase of re-planning comprising:

searching for potential alternative paths to assigned paths associated with on-network and predicted path-controlled trips that are further associated with at least one predicted relatively loaded link, wherein searches are performed independently, and wherein a search for a potential alternative path is performed by a shortest path algorithm according to predicted travel time costs on network links determined by traffic simulation associated with said model-predictive-control, wherein the simulation is fed by on-network and by predicted trips comprising trips associated with potential alternative paths that their travel times were accepted for traffic simulation evaluation in a prior re-planning phase, while searches exclude predicted relatively loaded links;

accepting for traffic simulation evaluation a potential alternative path if its related travel time may gain potential travel time improvement over travel time of its related assigned path and if its travel time is not exceeding a travel time limit composed of travel time related to a prior potential alternative path, which in prior re-planning phase was failed to comply with a prior such said travel time limit or with such said travel time improvement, plus a travel time limiting threshold determined for the current re-planning phase; and

determining acceptance of a path of pre-evaluated accepted potential alternative paths by performing traffic simulation prediction fed by on-network and by predicted trips, comprising path-controlled trips that their pre-evaluated potential alternative paths were accepted in current re-planning phase, and further by determining, according to the traffic simulation, evaluated acceptance of the path if its related travel time maintains said travel time limit and said potential travel time improvement.

11. The method of claim 10, wherein the travel time limiting threshold increases with a new phase of re-planning.

12. The method of claim 10, wherein said travel time limiting threshold is configured to enable to acceptably limit potential travel time discrimination among alternative paths.

13. The method of claim 10, wherein an accepted potential alternative path that its travel time was failed to comply with a said evaluation, is the path that its pre-evaluated travel time is used, in conjunction with said additional travel time limiting threshold determined for the subsequent re-planning phase, to determine for a subsequent re-planning phase said limit for acceptance of a pre-evaluated potential alternative path.

14. The method of claim 10, wherein the relative-loaded-links are prioritized relatively-loaded-links determined as a subset of the highest predicted relatively-loaded-links according to traffic simulation.

15. The method of claim 1, wherein said privilege, associated with the network usage, is determined by the support of traffic predictions of navigation system indicating on the level of usage enabling to apply traffic predictions under virtual independence of simulating modeled non path-controlled trips with planning of paths to path controlled trips.

16. The method of claim 1, wherein the privilege, associated with network usage, is adjusted to maximize traffic flow under potential increase in usage of path-controlled trips in relation to potential increase in traffic flow detected according to simulated traffic associated with the navigation control system.

17. A system comprising:

means for transmitting from a vehicle its position and destination to get served as an incentivized path-controlled trip by a navigation control system, and receiving a path for a path-controlled trip, wherein transmission of said position and destination and reception of said path use anonymous vehicle IP addressing, and wherein incentivized path controlled-trips are entitled with privileged network usage of free of charge toll or toll discount for obedience to the navigation control system applying, through path controlled trips, predictive traffic-load-balancing on at least a regional part of a city road network;

means for processing at the vehicle path updates from the navigation control system and transmitting from the vehicle position updates to the navigation control system, wherein reception of the path updates and transmission of the position updates use anonymous vehicle IP addressing;

means for determining, under in-vehicle control, one or more charging amounts related to the vehicle's network-usage, comprising:

tracking positions of the vehicle and determining matches and mismatches of tracked positions with positions that could acceptably be developed by the vehicle according to received path updates; and

determining at least one charging amount related to network-usage for one or more matches according to data determining privileged network usage cost, and a charging amount related to network-usage for one or more determined mismatches according to data determining non-privileged network usage cost, wherein privilege in network usage is configured to enable simulation-based traffic predictions, associated with model predictive control supporting planning of paths for said predictive traffic load balancing, to be independent of modeling non path-controlled trips; and

means for causing the vehicle to transmit charging related data, associating a charging related ID with at least one charging amount related to the vehicle's network-usage, according to a charging procedure allowed to expose a non-anonymous ID with charged network usage associated with a path-controlled trip.

18. The system of claim 17 comprising an in-vehicle toll charging unit that is configured to associate a charging related ID with at least one toll charging amount.

19. The system of claim 18, wherein association of the charging related ID with at least one toll charging amount enables charging by a charging system according to a determined charging procedure.

20. The system of claim 18, wherein the in-vehicle toll charging unit is configured to transmit authentication related data associated uniquely with the vehicle with at least one toll charging amount according to a determined charging procedure.