CLAIMS

1. A method for acquiring, positioning and tracking of vehicles travelling in airspace, sea and land travel routes via a constellation of small satellites, the method comprising:

(a) detecting a first signal from a vehicle travelling along a vehicle travel path;

(b) detecting an anomaly from the first signal;

(c) determining whether the anomaly occurs (i) inside a first radar mode coverage area or (ii) outside the first radar mode coverage area;

(d) activating (i) a first radar mode if the anomaly occurs inside the first radar mode coverage area for detecting a second signal from the vehicle or (ii) a second radar mode if the anomaly occurs outside the first radar mode coverage area for detecting a third signal from the vehicle for positioning the vehicle independently;

(e) cueing a third radar mode by the first or the second radar mode to (i) refine the second signal, or (ii) refine the third signal from the vehicle,

wherein the steps of (a), (b), (c), (d) and (e) are sequentially performed by satellites in the constellation of small satellites.

2. The method of claim 1, further comprising sequencing the first, second and third radar modes repeatedly to simultaneously provide surveillance, positioning and tracking of all fast and slow moving vehicles with or without anomalies in the airspace, sea and land travel routes.

3. The method of claim 1, wherein the first signal comprises a transponder signal utilizing a cooperative technique comprising ADS-B and AIS system.

4. The method of claim 1, wherein the second signal comprises a coarse positioning of the vehicle utilizing a non-cooperative technique comprising a Low Frequency Wide Swath Radar.

5. The method of claim 1, wherein the third signal comprises a transponder signal and/or a Bistatic signal reflected from the vehicle utilizing a Passive Coherent Radar technique.

6. The method of claim 1, wherein the refining the second or third signal comprising utilizing an active high resolution Microwave Imaging Radar to perform high resolution imaging and tracking of the vehicle.

7. The method of claim 1, wherein the detecting an anomaly from the first signal comprises:

(a) decoding the first signal;

(b) checking the integrity of the first signal; and

(c) deriving an outcome by comparing the expected positioning with the measured positioning of the first signal.

wherein the detected anomaly is sent to the satellite which is closest to the area of the vehicle.

8. The method of claim 1, wherein the activating the first radar mode comprises utilizing the Low Frequency Wide Swath Radar with information on anomaly to re-indicate the coarse positioning of the vehicle.

9. The method of claim 1, wherein the activating the second radar mode comprises activating a first gap filler mode or a second gap filler mode to detect the vehicle.

10. The method of claim 1, further comprising halting the first, second and third radar modes sequencing if a distressed vehicle is imaged and activating an emergency sequence by the third radar mode to continuously tracked the distressed vehicle.

11. The method of claim 1, wherein the third radar mode further comprises analyzing motions of a vehicle with anomaly by combining at least one of

- multiple hypothesis tracking matched to at least one kinematics of the vehicle to obtain an ISAR image of a dived trajectory/vehicle, and
- imaging to detect the positioning of a crash point or mid-air explosion of the vehicle by an Inverse SAR imaging technique.

12. The method of claim 11, wherein the imaging to detect the positioning of a crash point or mid-air explosion of the vehicle comprises utilizing

- an Inverse Synthetic Aperture Radar (ISAR) imaging process based on the angular and linear motions of the vehicle;
- Synthetic Aperture Radar imaging (SAR) imaging of the sea and land surfaces for suspicious disappearances such as a crash or an immediate floating debris; and
- combination of both the (a) ISAR and (b) SAR techniques.

13. A system for acquiring, positioning and tracking of vehicles travelling in airspace, sea and land routes via a constellation of small satellites, the system comprising:

- a first detecting means for detecting a first signal from a vehicle travelling along a vehicle travel path;
- a processing means for detecting an anomaly from the first signal and determining whether the anomaly occurs (i) inside a first radar mode coverage area or (ii) outside the first radar mode coverage area;
- a second detecting means for detecting a second signal from the vehicle under a first radar mode if the anomaly occurs inside the first radar mode coverage area;
- a third detecting means for detecting a third signal from the vehicle under a second radar mode in order to position the vehicle independently if the anomaly occurs outside the first radar mode coverage area;
- a fourth detecting means for (i) refining the second signal or (ii) refining the third signal from the vehicle under a third radar mode,

wherein the first, second, third and fourth detecting means are sequentially activated to detect the first, second and third signals by satellites in the constellation of small satellites.

14. The system of claim 13, wherein the constellation of small satellites comprises at least three satellites comprising Nano-Satellites, Micro-Satellites or Mini-Satellites.

15. The system of claims 13 or 14, wherein at least one of the satellites further comprises:

- a wideband receiver for receiving electromagnetic (EM) waves and/or signals from either (i) transponder signals from the vehicles, or (ii) Bistatic echo signals reflected off the vehicles;
- a low frequency wide swath radar with a transceiver operating in the low frequency band of either HF, VHF or UHF for detecting a distressed vehicle when it has moved randomly from a last known position;
- a high resolution Microwave Imaging Radar with a transceiver operating in the X-band microwave frequency for refining the positioning of the distressed vehicle using imaging functions;
- a storage/buffer unit for transmitting vehicle information from a satellite to a master ground station;
- a synchronization unit for synchronizing of three radar modes; and
- a processor for operational control of the functional units and processing of information such as detecting first, second and third signals from the initial detection, decoding and verification of anomaly, first, second, third and fourth detecting means, as well as performing the vehicle imagery and distress/emergency classifications.

16. The system of claim 13, wherein the first detection means comprises an Automatic Dependent Surveillance-Broadcast (ADS-B) or an Automatic Identification System (AIS) operating in a cooperative system environment.

17. The system of claim 13, wherein the second detection means comprises a Low Frequency Wide Swath Radar for detecting the second signal if the anomaly occurs inside the first radar mode coverage area.

18. The system of claim 13, wherein the second detection means further comprises a Passive Bistatic Coherent Radar for detecting the third signal reflected off the vehicle travelling outside the first radar mode coverage area.

19. The system of claim 13, wherein the fourth detection means comprises a Microwave Imaging Radar for performing high resolution imaging operations in the C, X, Ku or Ka frequency spectrum.

20. The system of claim 13, wherein at least one of the satellites in the constellation is deployed to provide a detection ground surveillance coverage gap between neighboring satellites corresponding to a satellite revisit time gap of two minutes.

21. The system of claim 13, wherein the third signal comprises signals of opportunity from ADS-B operating at 1090 +/-3MHz, AIS operating at 161,975 to 162,025 MHz, High Frequency Data Link (HFDL), FM Broadcast Emitters operating at 87.5 to 108.0 MHz, VOR/DME Emitters operating at 108 to 117.95 MHz, Geostationary Satellite Emitters and Ground-based and Airborne Radars.

22. A method for surveillance, integrity check and tracking of vehicles travelling in an airspace, sea and land routes, the method comprising:

- detecting transponder signals from a vehicle;
- checking the transponder signals for anomalies of the vehicle in a first radar mode;
- detecting the vehicle in a second radar mode if the anomalies are found in the first radar mode; and
- refining coarse positioning of the vehicle for positioning the vehicle by the first radar mode, the second radar mode or both independently for search and rescue operations.

23. The method of claim 22, wherein the step of checking the transponder signals for anomalies comprises:

- decoding the transponder signals;
- checking integrity of the transponder signals using a multilateration technique; and
- detecting an anomaly from the transponder signals, wherein a vehicle with an anomaly is a vehicle in distress.

24. The method of claim 23, wherein the checking integrity of the transponder signals comprises a multilateration technique comprising:

- Implementing Frequency Difference Of Arrival (FDOA) or Time Difference Of Arrival (TDOA) from a set of at least three satellites for measuring either differential Doppler frequencies and/or differential time of arrivals of the transponder signals;
- Computing either differential Doppler frequencies or differential time of arrival or both from the positioning data provided by the cooperative positioning system (transponder under ADS-B or AIS protocol); or
- Computing the difference between the measurements and the computed values to provide an integrity classification comprising a “True”, “False” or “Unclassified” category.

25. The method of claim 22, wherein the second step comprises detecting a distressed vehicle using a Passive Coherent Radar if the distressed vehicle is outside the Wide Swath Radar coverage.

26. The method of any of claims 22-25, wherein the step of refining coarse positioning of the vehicle comprises using a Microwave Radar to further accurately track the vehicle for search and rescue operations.

27. The method of claim 22, wherein the ground area covered by:

- the step of checking the transponder for anomalies in the first radar mode ranges from a diameter of 2000 - 3000km of a circumscribed circle based on semi-cooperative mode;
- the step of detecting the vehicle in the second radar mode ranges from a diameter of 1100 - 1600km of a circumscribed circle based on a non-cooperative mode; and
- the step of refining the coarse positioning of the vehicle for positioning the vehicle by the first radar mode or the second radar mode independently ranges from a diameter of up to 700km of a circumscribed circle based on a non-cooperative mode.

28. The method of claim 22, wherein
the first radar mode comprises a cooperative technique or a semi-cooperative mode.

29. The method of claim 22, wherein
the second radar mode comprises a non-cooperative technique.

30. The method of claim 22 further comprising
cueing a third radar mode by the first or second radar mode for refining the transponder signals.