CLAIMS

1. A device for determining its position for vehicular communication, the device comprises

a receiver module configured to receive the following as inputs:

a first positioning reference data from a first transmitter at a first time;

a second positioning reference data from a second transmitter at a second time;

a positioning assistance data associated with the first positioning reference data and the second positioning reference data, the positioning assistance data obtained from at least one intermediate user equipment;

and calculate a first reference signal timing difference and a second reference signal timing difference based on the first time and the second time; and

a fusion filter module configured to receive the first reference signal timing difference and the second reference signal timing difference; and determine a current location of the device based on the first reference signal timing difference, the second reference signal timing difference, and the positioning assistance data;

wherein the receiver module comprises one or more circuitries implementing a phase-locked loop (PLL) and a delay-locked loop (DLL).

2. The device of claim 1, further comprising an inertial measurement unit (IMU) arranged in data communication with the fusion filter module, the IMU configured to receive at least one parameter associated with the current location of the device and determine an acceleration data and angular rate as output.

3. The device of claim 1 or 2, wherein the first reference signal timing comprises a first carrier phase measurement and a first code phase measurement, and the second reference signal timing difference comprises a second carrier phase measurement and a second code phase measurement.

4. The device of any one of the preceding claims, further comprising an inertial navigation system (INS), the INS configured to receive the acceleration data and the angular rate as input

and determine a current position, a current velocity, and a current attitude of the device as output.

5. The device of claim 4, wherein the INS is configured to determine the current position, the current velocity, and the current attitude of the device based on a dead reckoning process.

6. The device of claim 5, wherein the fusion filter module is an extended Kalman filter module, wherein the extended Kalman filter module is configured to receive the current position, the current velocity, and the current attitude of the device as input to determine an estimate position, an estimate velocity, and an estimate attitude as outputs.

7. The device of any one of the preceding claims, wherein at least one of the first transmitter and the second transmitter is an 5G-NR base station.

8. The device of claim 7, wherein the 5G-NR base station is a gNodeB base station.

9. The device of any one of the preceding claims, wherein the intermediate user equipment comprises a roadside unit (RSU).

10. The device of claim 2, wherein the IMU comprises an accelerometer and a gyroscope, and the at least one parameter associated with the current location of the device comprises at least one of an accelerometer bias and a gyroscope bias.

11. The device of any one of the preceding claims, wherein the receiver module is a 5G software defined radio (SDR) receiver.

12. A system for determining a position of a target device for vehicular communication, the system comprising

a first transmitter configured to send a first positioning reference data to the target device, the target device configured to receive the first positioning reference data at a first time;

a second transmitter configured to send a second positioning reference data to the target device, the target device configured to receive the second positioning reference data at a second time;

at least one intermediate user equipment configured to send a positioning assistance data associated with the first positioning reference data and the second positioning reference data to the target device;

wherein the target device is a device of any one of claims 1 to 11.

13. The system of claim 12, wherein the system is a 5G-vehicle to everything (V2X) positioning system.

14. The system of claim 13, wherein at least one of the first transmitter and the second transmitter is a 5G-NR base station.

15. The system of claim 14, wherein the 5G-NR base station is a gNodeB base station.

16. The system of any one of claims 12 to 15, wherein the intermediate user equipment comprises a roadside unit (RSU).

17. A method for determining a position of a target device for vehicular communication, the method comprises

obtaining, at the target device, a first positioning reference data from a first transmitter at a first time, wherein the target device comprises a receiver module and the receiver module comprises one or more circuitries implementing a phase-locked loop (PLL) and a delay-locked loop (DLL);

obtaining, at the target device, a second positioning reference data from a second transmitter at a second time;

obtaining, at the target device, a positioning assistance data associated with the first positioning reference data and the second positioning reference data, the positioning assistance data obtained from at least one intermediate user equipment;

calculating, by a processor of the target device, a first reference signal timing difference and a second reference signal timing difference based on the first time and the second time;

determining, by the processor of the target device, a current location of the target device based on the first reference signal timing difference, the second reference signal timing difference, and the positioning assistance data.

18. The method of claim 17, wherein the determining of the current location further comprising a step of receiving at least one parameter associated with the current location of the device and determine an acceleration data and angular rate as output.

19. The method of claim 17 or claim 18, wherein the first reference signal timing difference comprises a first carrier phase measurement and a first code phase measurement, and the second reference signal timing difference comprises a second carrier phase measurement and a second code phase measurement.

20. A computer-readable medium comprising program instructions, which, when executed by one or more processors, cause the one or more processors to perform the method of any one of claims 17 to 19.