CLAIMS

1. A method of locating missing nodes in a network, comprising the steps of:

periodically receiving electronic GPS data including electronic GPS coordinates identifying the physical location of a mobile communication device, said mobile communication device comprising one or more radios, each radio having a respective receiver and corresponding antenna;

collecting radio frequency (RF) data transmissions sent by one or more missing nodes in proximity to the mobile communication device, wherein each said RF data transmission comprises at least a node identifier used to identify whether a node in proximity to the mobile communication device is a missing node;

determining a signal strength indicator from selected ones of the collected RF data transmissions, including those identified as being sent by missing nodes;

wherein said RF data transmissions are received by the one or more radios and are collected while the mobile communication device is positioned in at least first and second different locations relative to each said one or more missing nodes;

electronically implementing a triangulation procedure using the electronic GPS coordinates and the signal strength indicators for a given missing node as determined in said at least first and second different locations in order to identify an estimated location for the given missing node; and

providing the estimated location for the given missing node as electronic output to a user;

wherein said step of electronically implementing a triangulation procedure utilizes a weighted average of the GPS coordinates associated with different transmission collection locations such that transmission collection locations indicating a higher signal strength received from the missing node are weighted more heavily than transmission collection locations having a lower signal strength received from the missing node.

2. The method of claim 1, wherein the network comprises a utility meter network, the mobile communication device comprises a mobile meter reading device, the nodes comprise endpoints, and the node identifiers comprise endpoint identifiers.

3. The method of claim 2, further comprising a step of correlating GPS data in time with each collected RF data transmission for a missing endpoint.

4. The method of claim 2, wherein said signal strength identifier determined for selected ones of the collected RF data transmissions comprises a Received Signal Strength Indicator (RSSI) measuring the power in each received RF data transmission.

5. The method of claim 2, wherein said one or more radios comprise at least one radio comprising a side-looking antenna and at least one radio comprising an omni-directional antenna.

6. The method of claim 2, wherein said one or more radios comprise three radios, two radios comprising side-looking antennas and one radio comprising an omni-directional antenna.

7. The method of claim 2, wherein said step of electronically implementing a triangulation procedure is implemented in real time as GPS coordinates and RF data transmissions are collected by the radios in the mobile meter reading device.

8. The method of claim 2, wherein said step of electronically implementing a triangulation procedure is implemented post processing after data is obtained during a given meter reading route.

9. The method of claim 2, further comprising a step of extracting in-route meter data from out-of-route meter data to assist with determining which data is received from a missing endpoint as opposed to other known endpoints in the utility meter network.

10. The method of claim 2, wherein said step of providing the estimated location for the given missing endpoint as electronic output to a user comprises providing estimated latitude and longitude coordinates of the estimated location.

11. The method of claim 2, wherein said step of providing the estimated location for the given missing endpoint as electronic output to a user comprises displaying the estimated location as a graphical icon on an electronic mapping interface.

12. The method of claim 11, further comprising a step of calculating a confidence value for the estimated location and providing the confidence value as electronic output to a user.

13. A mobile data reading system, comprising:

a data collection unit, comprising:

a GPS module;

one or more radios, each radio comprising a receiver and an antenna; and

at least one memory module configured to store GPS coordinates periodically received from said GPS module and radio log files of data transmission collection information periodically collected from said one or more radios, wherein said radio log files comprise at least a node identifier associated with each data transmission collection and a signal strength indicator determined by the one or more radios; and

a processor coupled to said data collection unit, said processor configured to execute code in the form of a node locating application, said node locating application configured to access the GPS coordinates and radio log files stored in said at least one memory module, electronically implement a triangulation procedure using the GPS coordinates and the signal strength indicator for a given missing node as determined in at least first and second different locations in order to identify an estimated location for the given missing node, and provide the estimated location for the given missing node as electronic output to a user;

wherein the triangulation procedure implemented by said processor utilizes a weighted average of the GPS coordinates associated with different transmission collection locations such that transmission collection locations indicating a higher signal strength received from the missing node are weighted more heavily than transmission collection locations having a lower signal strength received from the missing node.

14. A mobile data reading system as in claim 13, wherein the mobile data reading system comprises a mobile meter reading system, the node identifier comprises an endpoint identifier, and the node locating application comprises an endpoint locating application.

15. A mobile meter reading system as in claim 14, wherein the data transmission collection information received by said one or more radios is collected while the mobile meter reading system is in a plurality of different locations, and wherein at least the signal strength indicator determined for each such data transmission collection is used in determining the estimated location for the given missing endpoint.

16. A mobile meter reading system as in claim 14, wherein said one or more radios comprise at least one radio comprising a side-looking antenna and at least one radio comprising an omni-directional antenna.

17. A mobile meter reading system as in claim 14, wherein said one or more radios comprise three radios, two radios comprising side-looking antennas and one radio comprising an omni-directional antenna.

18. A mobile meter reading system as in claim 14, wherein said one or more radios comprises at least one radio comprising a manually adjustable antenna.

19. A mobile meter reading system as in claim 14, further comprising an electronic display coupled to said processor, said display configured to show the estimated location of the missing endpoint as a graphical icon on an electronic mapping interface.

20. A mobile meter reading system as in claim 19, wherein said processor is further configured to calculate a confidence value for the estimated location and adjust the graphical icon on the electronic mapping interface based on the calculated confidence value.

21. One or more computer-readable media storing computer-executable instructions that, when executed by one or more processors, cause the one or more processors to perform acts comprising:

periodically receiving electronic GPS data including electronic GPS coordinates identifying the physical location of a mobile communication device, said mobile communication device comprising one or more radios, each radio having a respective receiver and corresponding antenna;

collecting radio frequency (RF) data transmissions sent by one or more missing nodes in proximity to the mobile communication device, wherein each said RF data transmission comprises at least a node identifier used to identify whether a node in proximity to the mobile communication device is a missing node;

determining a signal strength indicator from selected ones of the collected RF data transmissions, including those identified as being sent by missing nodes;

wherein said RF data transmissions are received by the one or more radios and are collected while the mobile communication device is positioned in at least first and second different locations relative to each said one or more missing nodes;

electronically implementing a triangulation procedure using the electronic GPS coordinates and the signal strength indicators for a given missing node as determined in

said at least first and second different locations in order to identify an estimated location for the given missing node; and

providing the estimated location for the given missing node as electronic output to a user;

wherein said act of electronically implementing a triangulation procedure utilizes a weighted average of the GPS coordinates associated with different transmission collection locations such that transmission collection locations indicating a higher signal strength received from the missing node are weighted more heavily than transmission collection locations having a lower signal strength received from the missing node.

22. The computer-readable media of claim 21, wherein the mobile communication device comprises a mobile meter reading device, the nodes comprise endpoints, and the node identifiers comprise endpoint identifiers.

23. The computer-readable media of claim 22, wherein the one or more processors are further configured to extract in-route meter data from out-of-route meter data to assist with determining which data is received from a missing endpoint as opposed to other known endpoints in the utility meter network.

24. The computer-readable media of claim 22, wherein said act of providing the estimated location for the given missing endpoint as electronic output to a user comprises providing estimated latitude and longitude coordinates of the estimated location.

25. The computer-readable media of claim 22, wherein said act of providing the estimated location for the given missing endpoint as electronic output to a user comprises displaying the estimated location as a graphical icon on an electronic mapping interface.

26. The computer-readable media of claim 22, wherein the one or more processors are further configured to calculate a confidence value for the estimated location and providing the confidence value as electronic output to a user.

WHAT IS CLAIMED:

1. A method of locating missing nodes in a network, comprising the steps of:

periodically receiving electronic GPS data including electronic GPS coordinates identifying the physical location of a mobile communication device, said mobile communication device comprising one or more radios, each radio having a respective receiver and corresponding antenna;

collecting radio frequency (RF) data transmissions sent by one or more missing nodes in proximity to the mobile communication device, wherein each said RF data transmission comprises at least a node identifier used to identify whether a node in proximity to the mobile communication device is a missing node;

determining a signal strength indicator from selected ones of the collected RF data transmissions, including those identified as being sent by missing nodes;

wherein said RF data transmissions are received by the one or more radios and are collected while the mobile communication device is positioned in at least first and second different locations relative to each said one or more missing nodes;

electronically implementing a triangulation procedure using the electronic GPS coordinates and the signal strength indicators for a given missing node as determined in said at least first and second different locations in order to identify an estimated location for the given missing node; and

providing the estimated location for the given missing node as electronic output to a user.

2. The method of claim 1, wherein the network comprises a utility meter network, the mobile communication device comprises a mobile meter reading device, the nodes comprise endpoints, and the node identifiers comprise endpoint identifiers.

3. The method of claim 2, further comprising a step of correlating GPS data in time with each collected RF data transmission for a missing endpoint.

4. The method of claim 2, wherein said signal strength identifier determined for selected ones of the collected RF data transmissions comprises a Received Signal Strength Indicator (RSSI) measuring the power in each received RF data transmission.

5. The method of claim 2, wherein said one or more radios comprise at least one radio comprising a side-looking antenna and at least one radio comprising an omni-directional antenna.

6. The method of claim 2, wherein said one or more radios comprise three radios, two radios comprising side-looking antennas and one radio comprising an omni-directional antenna.

7. The method of claim 2, wherein said step of electronically implementing a triangulation procedure utilizes a weighted average of the GPS coordinates associated with different transmission collection locations such that transmission collection locations indicating a higher signal strength received from the missing endpoint are weighted more heavily than transmission collection locations having a lower signal strength received from the missing endpoint.

8. The method of claim 2, wherein said step of electronically implementing a triangulation procedure is implemented in real time as GPS coordinates and RF data transmissions are collected by the radios in the mobile meter reading device.

9. The method of claim 2, wherein said step of electronically implementing a triangulation procedure is implemented post processing after data is obtained during a given meter reading route.

10. The method of claim 2, further comprising a step of extracting in-route meter data from out-of-route meter data to assist with determining which data is received from a missing endpoint as opposed to other known endpoints in the utility meter network.

11. The method of claim 2, wherein said step of providing the estimated location for the given missing endpoint as electronic output to a user comprises providing estimated latitude and longitude coordinates of the estimated location.

12. The method of claim 2, wherein said step of providing the estimated location for the given missing endpoint as electronic output to a user comprises displaying the estimated location as a graphical icon on an electronic mapping interface.

13. The method of claim 12, further comprising a step of calculating a confidence value for the estimated location and providing the confidence value as electronic output to a user.

14. A mobile data reading system, comprising:

a data collection unit, comprising:

a GPS module;

one or more radios, each radio comprising a receiver and an antenna; and

at least one memory module configured to store GPS coordinates periodically

received from said GPS module and radio log files of data transmission collection information periodically collected from said one or more radios, wherein said radio log files comprise at least a node identifier associated with each data transmission collection and a signal strength indicator determined by the one or more radios; and

a processor coupled to said data collection unit, said processor configured to execute code in the form of a node locating application, said node locating application configured to access the GPS coordinates and radio log files stored in said at least one memory module, electronically implement a triangulation procedure using the GPS coordinates and the signal strength indicator for a given missing node as determined in at least first and second different locations in order to identify an estimated location for the given missing node, and provide the estimated location for the given missing node as electronic output to a user.

15. A mobile data reading system as in claim 14, wherein the mobile data reading system comprises a mobile meter reading system, the node identifier comprises an endpoint identifier, and the node locating application comprises an endpoint locating application.

16. A mobile meter reading system as in claim 15, wherein the data transmission collection information received by said one or more radios is collected while the mobile meter reading system is in a plurality of different locations, and wherein at least the signal strength indicator determined for each such data transmission collection is used in determining the estimated location for the given missing endpoint.

17. A mobile meter reading system as in claim 15, wherein said one or more radios comprise at least one radio comprising a side-looking antenna and at least one radio comprising an omni-directional antenna.

18. A mobile meter reading system as in claim 15, wherein said one or more radios comprise three radios, two radios comprising side-looking antennas and one radio comprising an omni-directional antenna.

19. A mobile meter reading system as in claim 15, wherein said one or more radios comprises at least one radio comprising a manually adjustable antenna.

20. A mobile meter reading system as in claim 15, wherein the triangulation procedure implemented by said processor utilizes a weighted average of the GPS coordinates associated with different transmission collection locations such that transmission collection locations indicating a higher signal strength received from the missing endpoint are weighted more heavily than transmission collection locations having a lower signal strength received from the missing endpoint.

21. A mobile meter reading system as in claim 15, further comprising an electronic display coupled to said processor, said display configured to show the estimated location of the missing endpoint as a graphical icon on an electronic mapping interface.

22. A mobile meter reading system as in claim 21, wherein said processor is further configured to calculate a confidence value for the estimated location and adjust the graphical icon on the electronic mapping interface based on the calculated confidence value.

23. One or more computer-readable media storing computer-executable instructions that, when executed by one or more processors, cause the one or more processors to perform acts comprising:

periodically receiving electronic GPS data including electronic GPS coordinates identifying the physical location of a mobile communication device, said mobile communication device comprising one or more radios, each radio having a respective receiver and corresponding antenna;

collecting radio frequency (RF) data transmissions sent by one or more missing nodes in proximity to the mobile communication device, wherein each said RF data transmission comprises at least a node identifier used to identify whether a node in proximity to the mobile communication device is a missing node;

determining a signal strength indicator from selected ones of the collected RF data transmissions, including those identified as being sent by missing nodes;

wherein said RF data transmissions are received by the one or more radios and are collected while the mobile communication device is positioned in at least first and second different locations relative to each said one or more missing nodes;

electronically implementing a triangulation procedure using the electronic GPS coordinates and the signal strength indicators for a given missing node as determined in said at least first and second different locations in order to identify an estimated location for the given missing node; and

providing the estimated location for the given missing node as electronic output to a user.

24. The computer-readable media of claim 23, wherein the mobile communication device comprises a mobile meter reading device, the nodes comprise endpoints, and the node identifiers comprise endpoint identifiers.

25. The computer-readable media of claim 24, wherein said act of electronically implementing a triangulation procedure utilizes a weighted average of the GPS coordinates associated with different transmission collection locations such that transmission collection locations indicating a higher signal strength received from the missing endpoint are weighted more heavily than transmission collection locations having a lower signal strength received from the missing endpoint.

26. The computer-readable media of claim 24, wherein the one or more processors are further configured to extract in-route meter data from out-of-route meter data to assist with determining which data is received from a missing endpoint as opposed to other known endpoints in the utility meter network.

27. The computer-readable media of claim 24, wherein said act of providing the estimated location for the given missing endpoint as electronic output to a user comprises providing estimated latitude and longitude coordinates of the estimated location.

28. The computer-readable media of claim 24, wherein said act of providing the estimated location for the given missing endpoint as electronic output to a user comprises displaying the estimated location as a graphical icon on an electronic mapping interface.

29. The computer-readable media of claim 24, wherein the one or more processors are further configured to calculate a confidence value for the estimated location and providing the confidence value as electronic output to a user.