Claims

1. A method for discovering a topological location and phase for one or more utility devices in an electrical power distribution system, comprising:

receiving, by a headend system, descriptors from a plurality of utility devices connected to the electrical power distribution system, the descriptors being generated at the respective utility devices by processing sensor data obtained at the respective utility devices;

responsive to determining that at least a threshold number of descriptors for a regular mode have been received,

grouping, by the headend system, the plurality of utility devices to generate a current grouping by applying clustering algorithms to the descriptors of the plurality of utility devices;

comparing, by the headend system, the current grouping with past groupings to determine a confidence level of the current grouping; determining, by the headend system, whether the confidence level exceeds a threshold confidence value; and

in response to determining that the confidence level exceeds the threshold confidence value, assigning, by the headend system, at least one of a segment identifier or a phase identifier to one or more of the plurality of utility devices.

2. The method of claim l, further comprising:

determining whether the plurality of utility devices operate in a fast mode, wherein in the fast mode, the segment identifier or the phase identifier is assigned to a utility device in a shorter time period than the regular mode;

in response to determining that the plurality of utility devices operate in a fast mode and that sufficient descriptors for the fast mode have been received, grouping the plurality of utility devices by correlating the received descriptors for the fast mode;

generating assignment information by assigning at least one of a segment identifier or a phase identifier to an unknown utility device among the plurality of utility devices;

sending the assignment information to the unknown utility device; and

sending instructions to the plurality of utility devices to exit the fast mode.

3. The method of claim l, further comprising in response to determining that the confidence level does not exceed the threshold confidence value, generating and sending, by the headend system, a new descriptor configuration to one or more of the plurality of utility devices.

4. The method of claim l, wherein comparing the current grouping with past groupings to determine a confidence level of the grouping comprises assigning a high confidence level in response to determining that a set of utility devices are grouped together in the current grouping and the past groupings; and assigning a low confidence level in response to determining that a set of utility devices are grouped differently in the current grouping than the past groupings.

5. The method of claim l, further comprising:

determining that the descriptors contain synchronizing events; and

adjusting timing of other events in the descriptors using a time of occurrence of the synchronizing events as a reference time.

6. The method of claim 5, further comprising:

determining, based on the synchronizing events, time offsets for one or more of the plurality of utility devices; and transmitting instructions to the one or more of the plurality of utility devices to correct clocks according to the respective time offsets.

7. A method performed by a utility device to generate descriptors for discovering a topology and phase of an electrical power distribution system, comprising:

processing sensor data obtained by the utility device to generate processed data;

determining whether the utility device operates in a fast mode or In a regular mode, wherein the utility device generates descriptors at a higher rate when operating in the fast mode than when operating in the regular mode;

in response to determining that the utility device operates in the fast mode,

generating fast descriptors based on the processed data; and responsive to determining that at least a first threshold number of fast descriptors have

been generated, transmitting the fast descriptors to a headend system communicatively connected to the utility device; and

in response to determining that the utility device operates in the regular mode,

generating regular descriptors based on the processed data; and

responsive to determining that at least a second threshold number of regular descriptors have been generated, transmitting the regular descriptors to the headend system, wherein the second threshold number is higher than the first threshold number, and wherein the fast descriptors and the regular descriptors are different.

8. The method of claim 7, wherein processing the sensor data to generate processed data comprises one or more of filtering the sensor data, transforming the sensor data into a frequency domain, or normalizing the sensor data.

9. The method of claim 8, wherein processing the sensor data further comprises: identifying a disturbance by determining that a value of the processed data is outside a pre-determined range; and determining characteristics of the disturbance.

10. The method of claim 9, wherein the regular descriptors are generated to include one or more of the characteristics of the disturbance.

11. The method of claim 7, further comprising adjusting a reference time of the utility device in response to receiving instructions from the headend system to correct the reference time of the utility device.

12. The method of claim 7, further comprising:

operating the utility device in the fast mode in response to receiving a first user input at the utility device or a first instruction from the headend system; and

exiting the fast mode in response to receiving a second user input at the utility device or a second instruction from the headend system.

13 The method of claim 7, further comprising:

receiving assignment information of the utility device from the headend system; and

displaying the assignment information on a display device associated with the utility device.

14. A system, comprising:

a plurality of utility devices connected to an electrical power distribution system and communicatively connected to a headend system, each utility device of the plurality of utility devices is configured for:

processing sensor data obtained at the utility device to generate processed data;

generating and transmitting fast descriptors or regular descriptors based on the processed data; and the headend system configured for:

receiving the fast descriptors or the regular descriptors from the plurality of utility devices;

determining whether the plurality of utility devices operate in a fast mode or a regular mode, wherein in the fast mode, a segment identifier or a phase identifier is assigned to a utility device among the plurality of utility devices in a shorter time period than the regular mode;

responsive to determining that the plurality of utility devices operate in the regular mode,

grouping the plurality of utility devices to generate a current grouping by applying clustering algorithms to the regular descriptors of the plurality of utility devices;

comparing the current grouping with past groupings to determine a confidence level of the current grouping; and

assigning at least one of a segment identifier or a phase identifier to one or more of the plurality of utility devices based on the confidence level.

15. The system of claim 14, wherein each utility device of the plurality of utility devices is further configured for determining whether the utility device operates in the fast mode or the regular mode, wherein the regular descriptors are generated and transmitted in response to determining that the utility device operates in the regular mode

16. The system of claim 15, wherein each utility device of the plurality of utility devices is further configured for, in response to determining that the utility device operates in the fast mode, generating the fast descriptors based on the processed data; determining that at least a first threshold number of fast descriptors have been generated; and transmitting the fast descriptors to the headend system.

17. The system of claim 16, wherein each utility device of the plurality of utility devices is further configured for, in response to determining that the utility device operates in the regular mode, determining that at least a second threshold number of regular descriptors have been generated, wherein the regular descriptors are transmitted to the headend system in response to determining that at least the second threshold number of regular descriptors have been generated.

18. The system of claim 17, wherein:

determining that at least a first threshold number of fast descriptors have been generated comprises determining that the at least first threshold number of fast descriptors have been generated for a fast mode interval;

determining that at least a second threshold number of regular descriptors have been generated comprises determining that the at least second threshold number of regular descriptors have been generated for a pre-determined number of descriptor intervals; and

the fast mode interval is shorter than the descriptor interval.

19. The system of claim 14, wherein the headend system is further configured for:

determining whether the confidence level exceeds a threshold confidence value; and

in response to determining that the confidence level does not exceed the threshold confidence value, generating and sending a new descriptor configuration to one or more of the plurality of utility devices,

wherein assigning the at least one of a segment identifier or a phase identifier to one or more of the plurality of utility devices is performed in response to determining that the confidence level exceeds the threshold confidence value.

20. The system of claim 14, wherein the headend system is further configured for in response to determining that the plurality of utility devices operate in a fast mode,

grouping the plurality of utility devices by correlating the fast descriptors; generating assignment Information by assigning at least one of a segment identifier or a phase identifier to an unknown utility device among the plurality of utility devices using neighboring utility devices of the unknown utility device in the plurality of utility devices as references;

sending the assignment information to the unknown utility device; and

sending instructions to the plurality of utility devices to exit the fast mode.