

circuits, called lateral circuits, which branch from the feeder circuits. The management of the local distribution network often relies on telephone calls from consumers when an outage occurs or relies on field workers analyzing the local distribution network.

[0006] Power companies have attempted to upgrade the power grid using digital technology, sometimes called a “smart grid.” For example, more intelligent meters (sometimes called “smart meters”) are a type of advanced meter that identifies consumption in more detail than a conventional meter. The smart meter may then communicate that information via some network back to the local utility for monitoring and billing purposes (telemetry). While these recent advances in upgrading the power grid are beneficial, more advances are necessary. It has been reported that in the United States alone, half of generation capacity is unused, half the long distance transmission network capacity is unused, and two thirds of its local distribution is unused. Therefore, a need clearly exists to improve the management of the power grid.

BRIEF SUMMARY

[0006a] According to an aspect there is provided a method of managing an outage condition associated with at least one portion of a power grid, the method executable with computer having at least one processor and memory and comprising: receiving a plurality of event messages, wherein each of the plurality of event messages is indicative of a condition associated with the at least one portion of the power grid; determining, using the at least one processor, that at least one of the plurality of event messages is indicative of an outage condition associated with the at least one portion of the power grid; retrieving at least a portion of grid state data, wherein the grid state data is representative of current demand conditions of the power grid; retrieving at least a portion of connectivity data, wherein the connectivity data is representative of a physical configuration of the power grid; verifying, using the at least one processor, presence of the outage condition based on the grid state data and connectivity data from devices of the power grid; receiving, from a high-level entity of the power grid selected from the group consisting of a section, a feeder circuit, and a data management system (DMS), a suspension message to suspend processing the plurality of event messages from at least one device in the at least one portion of the power grid, the at least one device comprising a line sensor, wherein the suspension message is indicative of a detected undesired condition of the line sensor; determining that the line sensor is in a

suspend filter state when the suspension message exists while the high-level entity is in a state selected from the group consisting of: (i) performing a health check of the line sensor; (ii) an outage sensed condition; (iii) an outage confirmed condition; and (iv) a fault sensed condition; suspending processing of the event messages originating from the line sensor while in the suspend filter state; and terminating the suspend filter state responsive to receipt of a resume message from the high-level entity, thereby returning the line sensor to normal operation.

[0006b] According to another aspect there is provided a power grid outage management system comprising: an outage intelligence application executable by at least one processor of a computer, wherein the outage intelligence application is executable to: receive a plurality of event messages indicative of an operating condition associated with at least one portion of the power grid, wherein at least one of the plurality of event messages is indicative of an outage condition associated with the at least one portion of the power grid; retrieve at least a portion of grid state data from, wherein the grid state data is representative of current demand conditions of the power grid; retrieve at least a portion of connectivity data, wherein the connectivity data is representative of a physical configuration of the power grid; determine presence of an outage condition associated with the at least one portion of the power grid based on the at least one of the plurality of event messages, the grid state data, and the connectivity data from devices of the power grid; receive, from a high-level entity of the power grid selected from the group consisting of a section, a feeder circuit, and a data management system (DMS), a suspension message to suspend processing the plurality of event messages from at least one device in the at least one portion of the power grid, the at least one device comprising a line sensor, wherein the suspension message is indicative of a detected undesired condition of the line sensor; determine that the line sensor is in a suspend filter state when the suspension message exists while the outage intelligence application is in a state selected from the group consisting of: (i) performing a health check of the line sensor; (ii) an outage sensed condition; (iii) an outage confirmed condition; and (iv) a fault sensed condition; suspend processing of the event messages originating from the line sensor while in the suspend filter state; and terminate the suspend filter state responsive to receipt of a resume message from the high-level entity, thereby returning the line sensor to normal operation.

[0007] According to ~~one aspect of the disclosure~~an embodiment, an outage management system for a power grid is disclosed. The outage management system may include an outage intelligence application executable on one or more processors configured to receive event messages from various devices and portions of the power grid. The event messages may allow the outage intelligence application to determine when outage conditions may be present for a particular device or portion of the power grid. The outage intelligence application may determine a state of operation for one, some, or all of the devices and portion of the power grid that transmit the event messages. The outage intelligence application may receive data related to current demand conditions of the power grid and physical configuration of the power grid to confirm that an outage associated with the power grid is present upon receipt of an event message indicating such. The outage intelligence application may notify a central power authority of an outage occurrence enabling location and correction of the outage. The outage intelligence application may suspend processing messages received from a portions of the power grid experiencing outage conditions based on receipt of the event messages and may resume such processing when the outage conditions are no longer present.

[0008] According to ~~another aspect of the disclosure~~an embodiment, a fault intelligence application executable on at least one processor may be configured to receive phasor data (magnitude and

CLAIMS:

1. A method of managing an outage condition associated with at least one portion of a power grid, the method executable with a computer having at least one processor and memory and comprising:

receiving a plurality of event messages, wherein each of the plurality of event messages is indicative of a condition associated with the at least one portion of the power grid;

determining, using the at least one processor, that at least one of the plurality of event messages is indicative of an outage condition associated with the at least one portion of the power grid;

retrieving at least a portion of grid state data, wherein the grid state data is representative of current demand conditions of the power grid;

retrieving at least a portion of connectivity data, wherein the connectivity data is representative of a physical configuration of the power grid;

verifying, using the at least one processor, presence of the outage condition based on the grid state data and connectivity data from devices of the power grid;

generating, using the processor, a sustained outage condition message representative of the outage condition, wherein the sustained outage condition message is configured to provide notification of the outage condition;

receiving, from a high-level entity of the power grid selected from the group consisting of a section, a feeder circuit, and a data management system (DMS), a suspension message to suspend processing the plurality of event messages from at least one device in the at least one portion of the power grid responsive to the sustained outage condition message, the at least one device comprising a line sensor, wherein the suspension message is indicative of a detected undesired condition of the line sensor;

determining that the line sensor is in a suspend filter state when a suspension message related to the line sensor exists while the high-level entity is in a state selected from the group consisting of: (i) performing a health check of the line sensor; (ii) an outage sensed condition; (iii) an outage confirmed condition; and (iv) a fault sensed condition;

suspending processing of the event messages originating from the line sensor while in the suspend filter state; and

terminating the suspend filter state responsive to receipt of a resume message from the high-level entity, thereby returning the line sensor to normal operation.

2. The method of claim 1, further comprising:

determining a first state associated with the at least a portion of the power grid based on the plurality of event messages, wherein the first state is indicative of operation of the at least one portion of the power grid in absence of the outage condition, and

determining a second state associated with the at least a portion of the power grid based on the at least one of the plurality of event messages is indicative of the outage condition; and

wherein, generating the at least one message representative of the outage condition comprises determining the second state.

3. The method of claim 1, wherein receiving the plurality of event messages indicative of the outage condition includes receiving a power outage notification message from the at least one portion of the power grid, wherein the power outage notification message is configured to indicate presence of the outage condition.

4. The method of claim 3, further comprising receiving a power restoration notification message from the at least one portion of the power grid upon elimination of the outage condition from the at least a portion of the power grid.

5. A power grid outage management system comprising:

an outage intelligence application executable by at least one processor of a computer, wherein the outage intelligence application is executable to:

receive a plurality of event messages indicative of an operating condition associated with at least one portion of the power grid, wherein at least one of the plurality of event messages is indicative of an outage condition associated with the at least one portion of the power grid;

retrieve at least a portion of grid state data from, wherein the grid state data is representative of current demand conditions of the power grid;

retrieve at least a portion of connectivity data, wherein the connectivity data is representative of a physical configuration of the power grid;

determine presence of an outage condition associated with the at least one portion of the power grid based on the at least one of the plurality of event messages, the grid state data, and the connectivity data from devices of the power grid;

generate a sustained outage condition message indicative of the presence of the outage condition, wherein the sustained outage condition message is configured to provide notification of the presence of the outage condition to a central power authority;

receive, from a high-level entity of the power grid selected from the group consisting of a section, a feeder circuit, and a data management system (DMS), a suspension message to suspend processing the plurality of event messages from at least one device in the at least one portion of the power grid responsive to the sustained outage condition message, the at least one device comprising a line sensor, wherein the suspension message is indicative of a detected undesired condition of the line sensor;

determine that the line sensor is in a suspend filter state when a suspension message related to the line sensor exists while the outage intelligence application is in a state selected from the group consisting of: (i) performing a health check of the line sensor; (ii) an outage sensed condition; (iii) an outage confirmed condition; and (iv) a fault sensed condition;

suspend processing of the event messages originating from the line sensor while in the suspend filter state; and

terminate the suspend filter state responsive to receipt of a resume message from the high-level entity, thereby returning the line sensor to normal operation.

6. The power grid outage management system of claim 5, wherein the outage intelligence application is further executable to:

determine an amount of time the outage condition is present;

compare the amount of time to a predetermined period of time;

determine that the outage condition is a sustained outage condition when the determined amount of time is greater than the predetermined amount of time; and

indicate the outage condition is a sustained outage condition in the sustained outage condition message.

7. The power grid outage management system of claim 5, wherein the outage intelligence application is further executable to:

- determine an amount of time the outage condition is present;
- compare the amount of time to a predetermined period of time;
- determine that the outage condition is a momentary outage condition when the determined amount of time is less than the predetermined amount of time; and
- indicate the outage condition is a momentary outage condition in a momentary outage event message.

8. The power grid outage management system of claim 7, wherein the outage intelligence application is further executable to transmit the momentary outage event message to be saved in an outage event log.

9. The power grid outage management system of claim 5, wherein the outage intelligence application is further executable to:

- receive at least one resume message to resume processing of plurality of event messages;
- and
- resuming processing of the plurality of event messages based on receipt of the at least one resume message.

10. The power system outage management system of claim 5, wherein the at least one portion of the power grid is a feeder circuit, wherein the outage intelligence application is further executable to:

- generate at least one message indicative of the presence of the outage condition within the feeder circuit, wherein the at least one message is configured to provide notification of the presence of the outage condition within the feeder circuit to a central power authority.

11. The power system outage management system of claim 10, wherein the outage intelligence application is further executable to suspend processing event messages from at least one device interconnected to the feeder circuit based on the presence of the outage condition on the feeder circuit.

CLAIMS:

1. A method of managing an outage condition associated with at least one portion of a power grid, the method executable with computer having at least one processor and memory and comprising:

receiving a plurality of event messages, wherein each of the plurality of event messages is indicative of a condition associated with the at least one portion of the power grid;

determining, using the at least one processor, that at least one of the plurality of event messages is indicative of an outage condition associated with the at least one portion of the power grid;

retrieving at least a portion of grid state data, wherein the grid state data is representative of current demand conditions of the power grid;

retrieving at least a portion of connectivity data, wherein the connectivity data is representative of a physical configuration of the power grid;

verifying, using the at least one processor, presence of the outage condition based on the grid state data and connectivity data from devices of the power grid;

receiving, from a high-level entity of the power grid selected from the group consisting of a section, a feeder circuit, and a data management system (DMS), a suspension message to suspend processing the plurality of event messages from at least one device in the at least one portion of the power grid, the at least one device comprising a line sensor, wherein the suspension message is indicative of a detected undesired condition of the line sensor;

determining that the line sensor is in a suspend filter state when the suspension message exists while the high-level entity is in a state selected from the group consisting of: (i) performing a health check of the line sensor; (ii) an outage sensed condition; (iii) an outage confirmed condition; and (iv) a fault sensed condition;

suspending processing of the event messages originating from the line sensor while in the suspend filter state; and

terminating the suspend filter state responsive to receipt of a resume message from the high-level entity, thereby returning the line sensor to normal operation.

2. The method of claim 1, further comprising:

determining a first state associated with the at least a portion of the power grid based on the plurality of event messages, wherein the first state is indicative of operation of the at least one portion of the power grid in absence of the outage condition; and

determining a second state associated with the at least a portion of the power grid based on the at least one of the plurality of event messages is indicative of the outage condition; and

wherein, generating the at least one message representative of the outage condition comprises determining the second state.

3. The method of claim 1, wherein receiving the plurality of event messages indicative of the outage condition includes receiving a power outage notification message from the at least one portion of the power grid, wherein the power outage notification message is configured to indicate presence of the outage condition.

4. The method of claim 3, further comprising receiving a power restoration notification message from the at least one portion of the power grid upon elimination of the outage condition from the at least a portion of the power grid.

5. A power grid outage management system comprising:
an outage intelligence application executable by at least one processor of a computer, wherein the outage intelligence application is executable to:

receive a plurality of event messages indicative of an operating condition associated with at least one portion of the power grid, wherein at least one of the plurality of event messages is indicative of an outage condition associated with the at least one portion of the power grid;

retrieve at least a portion of grid state data from, wherein the grid state data is representative of current demand conditions of the power grid;

retrieve at least a portion of connectivity data, wherein the connectivity data is representative of a physical configuration of the power grid;

determine presence of an outage condition associated with the at least one portion of the power grid based on the at least one of the plurality of event messages, the grid state data, and the connectivity data from devices of the power grid;

receive, from a high-level entity of the power grid selected from the group consisting of a section, a feeder circuit, and a data management system (DMS), a

suspension message to suspend processing the plurality of event messages from at least one device in the at least one portion of the power grid, the at least one device comprising a line sensor, wherein the suspension message is indicative of a detected undesired condition of the line sensor;

determine that the line sensor is in a suspend filter state when the suspension message exists while the outage intelligence application is in a state selected from the group consisting of: (i) performing a health check of the line sensor; (ii) an outage sensed condition; (iii) an outage confirmed condition; and (iv) a fault sensed condition;

suspend processing of the event messages originating from the line sensor while in the suspend filter state; and

terminate the suspend filter state responsive to receipt of a resume message from the high-level entity, thereby returning the line sensor to normal operation.

6. The power grid outage management system of claim 5, wherein the outage intelligence application is further executable to:

determine an amount of time the outage condition is present;

compare the amount of time to a predetermined period of time;

determine that the outage condition is a sustained outage condition when the determined amount of time is greater than the predetermined amount of time; and

indicate the outage condition is a sustained outage condition in the sustained outage condition message.

7. The power grid outage management system of claim 5, wherein the outage intelligence application is further executable to:

determine an amount of time the outage condition is present;

compare the amount of time to a predetermined period of time;

determine that the outage condition is a momentary outage condition when the determined amount of time is less than the predetermined amount of time; and

indicate the outage condition is a momentary outage condition in a momentary outage event message.

8. The power grid outage management system of claim 7, wherein the outage intelligence application is further executable to transmit the momentary outage event message to be saved in an outage event log.

9. The power grid outage management system of claim 5, wherein the outage intelligence application is further executable to:

receive at least one resume message to resume processing of the plurality of event messages; and

resuming processing of the plurality of event messages based on receipt of the at least one resume message.

10. The power system outage management system of claim 5, wherein the at least one portion of the power grid is a feeder circuit, wherein the outage intelligence application is further executable to:

generate at least one message indicative of the presence of the outage condition within the feeder circuit, wherein the at least one message is configured to provide notification of the presence of the outage condition within the feeder circuit to a central power authority.

11. The power system outage management system of claim 10, wherein the outage intelligence application is further executable to suspend processing event messages from at least one device interconnected to the feeder circuit based on the presence of the outage condition on the feeder circuit.