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AUTOMATED CLOUD HOSTED BMS ARCHIVE AND DIFFERENCE ENGINE

Abstract

A method for determining updates in a building management system (BMS) is shown. The method includes receiving, via an on premise server, configuration data associated with at least part of the BMS. The method includes storing the configuration data within a cloud server communicably coupled with the on premise server. The method includes determining, via a difference engine within the cloud server, information comprising a delta between the configuration data and one or more previous sets of configuration data stored within the cloud server. The method includes providing, to the on premise server, the information to an interface.

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Background/Summary

CROSS REFERENCE TO RELATED PATENT APPLICATIONS [0001] This application is a continuation of U.S. patent application Ser. No. 17/575,944 filed Jan. 14, 2022, the entire disclosure of which is incorporated by reference herein.

BACKGROUND

[0002] The present disclosure relates generally to building management systems (BMS). More specifically, the present disclosure relates to storage and analytics within a BMS cloud server.

SUMMARY

[0003] This summary is illustrative only and is not intended to be in any way limiting. Other aspects, inventive features, and advantages of the devices or processes described herein will become apparent in the detailed description set forth herein, taken in conjunction with the accompanying figures, wherein like reference numerals refer to like elements.

[0004] One implementation of the present disclosure is a method for determining updates in a building management system (BMS). The method includes receiving, via an on premise server, configuration data associated with at least part of the BMS. The method includes storing the configuration data within a cloud server communicably coupled with the on premise server. The method includes determining, via a difference engine within the cloud server, information comprising a delta between the configuration data and one or more previous sets of configuration data stored within the cloud server. The method includes providing, to the on premise server, the information to an interface.

[0005] In some embodiments, determining the information comprising the delta includes determining, based on the configuration data, one or more equipment that have been added to the BMS, and determining an increase in energy costs resulting from the one or more equipment being added to the BMS, wherein the information comprises the energy costs.

[0006] In some embodiments, the method further includes receiving, via the interface, instructions to restore the BMS to a previous implementation, the previous implementation based on old configuration data of the BMS and providing control signals to the BMS such that the BMS operates in accordance with the old configuration data of the BMS.

[0007] In some embodiments, determining the information comprising the delta includes categorizing the configuration data such that the configuration data is categorized at least partially into at least one of a list of equipment within the BMS or a list of spaces within the BMS or a list of extensions associated with the equipment in the BMS, and providing the at least one of the list of equipment within the BMS or the list of spaces within the BMS or the list of extensions associated with the equipment in the BMS to the interface, in response to a request received via the interface.

[0008] In some embodiments, storing the configuration data within the cloud server communicably coupled with the on premise server includes storing a plurality of configuration data sets representing operation of the BMS at different time periods, wherein the plurality of configuration data sets comprise the configuration data and the one or more previous sets of configuration data, and provide the plurality of configuration data sets to the interface such that the interface displays the plurality of configuration data sets in sequential order.

[0009] In some embodiments, determining the information comprising the delta includes determining, based on the configuration data, one or more objects that have been added to the BMS, wherein the information comprises an updated number of objects within the BMS.

[0010] In some embodiments, providing, to the on premise server, the information to the interface includes providing at least one of an email or a text message indicative of the delta between the configuration data and one or more previous sets of configuration data to the interface, in response to a request received via the interface.
[0011] Another implementation of the present disclosure is one or more computer readable media (CRM) for determining updates in a building management system (BMS), the one or more CRM including one or more processors configured to perform operations. The operations include receiving, via an on premise server, configuration data associated with at least part of the BMS, storing the configuration data within a cloud server communicably coupled with the on premise server, determining, via a difference engine within the cloud server, information comprising a delta between the configuration data and one or more previous sets of configuration data stored within the cloud server, and providing, to the on premise server, the information to an interface.
[0012] In some embodiments, determining the information comprising the delta includes determining, based on the configuration data, one or more equipment that have been added to the BMS, and determining an increase in energy costs resulting from the one or more equipment being added to the BMS, wherein the information comprises the energy costs.
[0013] In some embodiments, the processing circuit is further configured to receive, via the interface, instructions to restore the BMS to a previous implementation, the previous implementation based on old configuration data of the BMS and providing control signals to the BMS such that the BMS operates in accordance with the old configuration data of the BMS.
[0014] In some embodiments, determining the information comprising the delta includes categorizing the configuration data such that the configuration data is categorized at least partially into at least one of a list of equipment within the BMS or a list of spaces within the BMS or a list of extensions associated with the equipment in the BMS, and providing the at least one of the list of equipment within the BMS or the list of spaces within the BMS or the list of extensions associated with the equipment in the BMS to the interface, in response to a request received via the interface.
[0015] In some embodiments, storing the configuration data within the cloud server communicably coupled with the on premise server includes storing a plurality of configuration data sets representing operation of the BMS at different time periods, wherein the plurality of configuration data sets comprise the configuration data and the one or more previous sets of configuration data, and provide the plurality of configuration data sets to the interface such that the interface displays the plurality of configuration data sets in sequential order.
[0016] In some embodiments, determining the information comprising the delta includes determining, based on the configuration data, one or more objects that have been added to the BMS, wherein the information comprises an updated number of objects within the BMS.
[0017] In some embodiments, providing, to the on premise server, the information to the interface includes providing at least one of an email or a text message indicative of the delta between the configuration data and one or more previous sets of configuration data to the interface, in response to a request received via the interface.
[0018] Another implementation of the present disclosure is a building platform for determining updates in a building management system (BMS) of the building. The building platform includes a processing device including a processing circuit configured to receive, via an on premise server, configuration data associated with at least part of the BMS, store the configuration data within a cloud server communicably coupled with the on premise server, determine, via a difference engine within the cloud server, information comprising a delta between the configuration data and one or more previous sets of configuration data stored within the cloud server, provide, to the on premise server, the information to an interface, provide, via the interface, instructions to restore the BMS to a previous implementation, the previous implementation based on old configuration data of the BMS, and provide control signals to the BMS such that the BMS operates in accordance with the old configuration data of the BMS.

[0019] In some embodiments, determining the information comprising the delta includes determining, based on the configuration data, one or more equipment that have been added to the BMS, and determining an increase in energy costs resulting from the one or more equipment being added to the BMS, wherein the information comprises the energy costs.
[0020] In some embodiments, determining the information comprising the delta includes categorizing the configuration data such that the configuration data is categorized at least partially into at least one of a list of equipment within the BMS or a list of spaces within the BMS or a list of extensions associated with the equipment in the BMS, and providing the at least one of the list of equipment within the BMS or the list of spaces within the BMS or the list of extensions associated with the equipment in the BMS to the interface, in response to a request received via the interface.
[0021] In some embodiments, storing the configuration data within the cloud server communicably coupled with the on premise server includes storing a plurality of configuration data sets representing operation of the BMS at different time periods, wherein the plurality of configuration data sets comprise the configuration data and the one or more previous sets of configuration data, and provide the plurality of configuration data sets to the interface such that the interface displays the plurality of configuration data sets in sequential order.
[0022] In some embodiments, determining the information comprising the delta includes determining, based on the configuration data, one or more objects that have been added to the BMS, wherein the information comprises an updated number of objects within the BMS.
[0023] In some embodiments, providing, to the on premise server, the information to the interface includes providing at least one of an email or a text message indicative of the delta between the configuration data and one or more previous sets of configuration data to the interface, in response to a request received via the interface.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0024] FIG. **1** is a schematic drawing of a building equipped with an HVAC system, according to some embodiments.
[0025] FIG. **2** is a schematic drawing of a waterside system which can be used as part of the HVAC system of FIG. **1**, according to some embodiments.
[0026] FIG. **3** is a block diagram of an airside system which can be used as part of the HVAC system of FIG. **1**, according to some embodiments.
[0027] FIG. **4** is a block diagram of a BMS which can be used in the building of FIG. **1**, according to some embodiments.
[0028] FIG. **5** is a block diagram of a data transfer system that may be communicably coupled with the BMS of FIG. **4**, according to some embodiments.
[0029] FIG. **6** is a block diagram of a cloud server, which may be implemented in the data transfer system of FIG. **5**, according to some embodiments.
[0030] FIG. **7**A is a diagram of an interface, which may be populated with data from the cloud server of FIG. **6**, according to some embodiments.
[0031] FIG. **7**B is a diagram of an interface, which may be populated with data from the cloud server of FIG. **6**, according to some embodiments.
[0032] FIG. **8** is a flow diagram of a process for determining deltas between multiple BMS data sets, which can be performed by the cloud server of FIG. **6**, according to some embodiments.
DETAILED DESCRIPTION
Overview
[0033] Referring generally to the FIGURES, systems and methods for determining changes in building management systems using a difference engine off-premise, based on multiple backups of

BMS data (e.g., uploaded every month, uploaded every week, etc.). The difference engine may compare the new BMS data with previous sets of received BMS data to determine "deltas" (e.g., differences between the data sets), such as equipment changes, relationship changes (e.g., between entities defined under a communications protocol), object quantity changes (e.g., number of BACnet objects defined within the BMS), or any combination thereof. The difference engine, or a processing device hosting the difference engine, may then provide updates, recommendations, changes, and other information to an interface (e.g., a workstation within the building, etc.) for further analysis.

Building Management System and HVAC System

HVAC System

[0034] Referring now to FIG. **1**, a perspective view of a building **10** is shown. Building **10** is served by a building management system (BMS). A BMS is, in general, a system of devices configured to control, monitor, and manage equipment in or around a building or building area. A BMS can include, for example, an HVAC system, a security system, a lighting system, a fire alerting system, any other system that is capable of managing building functions or devices, or any combination thereof.

[0035] The BMS that serves building **10** includes an HVAC system **100**. HVAC system **100** may include a plurality of HVAC devices (e.g., heaters, chillers, air handling units, pumps, fans, thermal energy storage, etc.) configured to provide heating, cooling, ventilation, or other services for building **10**. For example, HVAC system **100** is shown to include a waterside system **120** and an airside system **130**. Waterside system **120** may provide a heated or chilled fluid to an air handling unit of airside system **130**. A irside system **130** may use the heated or chilled fluid to heat or cool an airflow provided to building **10**. In some embodiments, waterside system **120** is replaced with a central energy plant such as central plant **200**, described with reference to FIG. **2**.

[0036] In some embodiments, building **10** acts as a building or campus (e.g., several buildings) capable of housing some or all components of HVAC system **100**. While the systems and methods described herein are primarily focused on operations within a typical building (e.g., building **10**), they can easily be applied to various other enclosures or spaces (e.g., cars, airplanes, recreational vehicles, etc.).

[0037] Still referring to FIG. **1**, HVAC system **100** is shown to include a chiller **102**, a boiler **104**, and a rooftop air handling unit (AHU) **106**. Waterside system **120** may use boiler **104** and chiller **102** to heat or cool a working fluid (e.g., water, glycol, etc.) and may circulate the working fluid to AHU **106**. In various embodiments, the HVAC devices of waterside system **120** may be located in or around building **10** (as shown in FIG. **1**) or at an offsite location such as a central plant (e.g., a chiller plant, a steam plant, a heat plant, etc.). The working fluid may be heated in boiler **104** or cooled in chiller **102**, depending on whether heating or cooling is required in building **10**. Boiler **104** may add heat to the circulated fluid, for example, by burning a combustible material (e.g., natural gas) or using an electric heating element. Chiller **102** may place the circulated fluid in a heat exchange relationship with another fluid (e.g., a refrigerant) in a heat exchanger (e.g., an evaporator) to absorb heat from the circulated fluid. The working fluid from chiller **102** and/or boiler **104** may be transported to AHU **106** via piping **108**.

[0038] AHU **106** may place the working fluid in a heat exchange relationship with an airflow passing through AHU **106** (e.g., via one or more stages of cooling coils and/or heating coils). The airflow may be, for example, outside air, return air from within building **10**, or a combination of both. AHU **106** may transfer heat between the airflow and the working fluid to provide heating or cooling for the airflow. For example, AHU **106** may include one or more fans or blowers configured to pass the airflow over or through a heat exchanger containing the working fluid. The working fluid may then return to chiller **102** or boiler **104** via piping **110**.

[0039] Airside system **130** may deliver the airflow supplied by AHU **106** (i.e., the supply airflow) to building **10** via air supply ducts **112** and may provide return air from building **10** to AHU **106** via air return ducts **114**. In some embodiments, airside system **130** includes multiple variable air volume (VAV) units **116**. For example, airside system **130** is shown to include a separate VAV unit **116** on each floor or zone of building **10**. VAV units **116** may include dampers or other flow control elements that can be operated to control an amount of the supply airflow provided to individual zones of building **10**. In other embodiments, airside system **130** delivers the supply airflow into one or more zones of building **10** (e.g., via air supply ducts **112**) without using intermediate VAV units **116** or other flow control elements. AHU **106** may include various sensors (e.g., temperature sensors, pressure sensors, etc.) configured to measure attributes of the supply airflow. AHU **106** may receive input from sensors located within AHU **106** and/or within the building zone and may adjust the flowrate, temperature, or other attributes of the supply airflow through AHU **106** to achieve setpoint conditions for the building zone.

Waterside System

[0040] Referring now to FIG. **2**, a block diagram of a central plant **200** is shown, according to an exemplary embodiment. In brief overview, central plant **200** may include various types of equipment configured to serve the thermal energy loads of a building or campus (i.e., a system of buildings). For example, central plant **200** may include heaters, chillers, heat recovery chillers, cooling towers, or other types of equipment configured to serve the heating and/or cooling loads of a building or campus. Central plant **200** may consume resources from a utility (e.g., electricity, water, natural gas, etc.) to heat or cool a working fluid that is circulated to one or more buildings or stored for later use (e.g., in thermal energy storage tanks) to provide heating or cooling for the buildings. In various embodiments, central plant **200** may supplement or replace waterside system **120** in building **10** or may be implemented separate from building **10** (e.g., at an offsite location).

[0041] Central plant **200** is shown to include a plurality of subplants **202-212** including a heater subplant **202**, a heat recovery chiller subplant **204**, a chiller subplant **206**, a cooling tower subplant **208**, a hot thermal energy storage (TES) subplant **210**, and a cold thermal energy storage (TES) subplant **212**. Subplants **202-212** consume resources from utilities to serve the thermal energy loads (e.g., hot water, cold water, heating, cooling, etc.) of a building or campus. For example, heater subplant **202** may be configured to heat water in a hot water loop **214** that circulates the hot water between heater subplant **202** and building **10**. Chiller subplant **206** may be configured to chill water in a cold water loop **216** that circulates the cold water between chiller subplant **206** and building **10**. Heat recovery chiller subplant **204** may be configured to transfer heat from cold water loop **216** to hot water loop **214** to provide additional heating for the hot water and additional cooling for the cold water. Condenser water loop **218** may absorb heat from the cold water in chiller subplant **206** and reject the absorbed heat in cooling tower subplant **208** or transfer the absorbed heat to hot water loop **214**. Hot TES subplant **210** and cold TES subplant **212** may store hot and cold thermal energy, respectively, for subsequent use.

[0042] Hot water loop **214** and cold water loop **216** may deliver the heated and/or chilled water to air handlers located on the rooftop of building **10** (e.g., AHU **106**) or to individual floors or zones of building **10** (e.g., VAV units **116**). The air handlers push air past heat exchangers (e.g., heating coils or cooling coils) through which the water flows to provide heating or cooling for the air. The heated or cooled air may be delivered to individual zones of building **10** to serve the thermal energy loads of building **10**. The water then returns to subplants **202-212** to receive further heating or cooling.

[0043] Although subplants **202-212** are shown and described as heating and cooling water for circulation to a building, it is understood that any other type of working fluid (e.g., glycol, CO.sub.2, etc.) may be used in place of or in addition to water to serve the thermal energy loads. In other embodiments, subplants **202-212** may provide heating and/or cooling directly to the building or campus without requiring an intermediate heat transfer fluid. These and other variations to central plant **200** are within the teachings of the present invention.

[0044] Each of subplants **202-212** may include a variety of equipment configured to facilitate the functions of the subplant. For example, heater subplant **202** is shown to include a plurality of heating elements **220** (e.g., boilers, electric heaters, etc.) configured to add heat to the hot water in hot water loop **214**. Heater subplant **202** is also shown to include several pumps **222** and **224** configured to circulate the hot water in hot water loop **214** and to control the flowrate of the hot water through individual heating elements **220**. Chiller subplant **206** is shown to include a plurality of chillers **232** configured to remove heat from the cold water in cold water loop **216**. Chiller subplant **206** is also shown to include several pumps **234** and **236** configured to circulate the cold water in cold water loop **216** and to control the flowrate of the cold water through individual chillers **232**.

[0045] Heat recovery chiller subplant **204** is shown to include a plurality of heat recovery heat exchangers **226** (e.g., refrigeration circuits) configured to transfer heat from cold water loop **216** to hot water loop **214**. Heat recovery chiller subplant **204** is also shown to include several pumps **228** and **230** configured to circulate the hot water and/or cold water through heat recovery heat exchangers **226** and to control the flowrate of the water through individual heat recovery heat exchangers **226**. Cooling tower subplant **208** is shown to include a plurality of cooling towers **238** configured to remove heat from the condenser water in condenser water loop **218**. Cooling tower subplant **208** is also shown to include several pumps **240** configured to circulate the condenser water in condenser water loop **218** and to control the flowrate of the condenser water through individual cooling towers **238**.

[0046] Hot TES subplant **210** is shown to include a hot TES tank **242** configured to store the hot water for later use. Hot TES subplant **210** may also include one or more pumps or valves configured to control the flowrate of the hot water into or out of hot TES tank **242**. Cold TES subplant **212** is shown to include cold TES tanks **244** configured to store the cold water for later use. Cold TES subplant **212** may also include one or more pumps or valves configured to control the flowrate of the cold water into or out of cold TES tanks **244**.

[0047] In some embodiments, one or more of the pumps in central plant **200** (e.g., pumps **222**, **224**, **228**, **230**, **234**, **236**, and/or **240**) or pipelines in central plant **200** include an isolation valve associated therewith. Isolation valves may be integrated with the pumps or positioned upstream or downstream of the pumps to control the fluid flows in central plant **200**. In various embodiments, central plant **200** may include more, fewer, or different types of devices and/or subplants based on the particular configuration of central plant **200** and the types of loads served by central plant **200**.

Airside System

[0048] Referring now to FIG. **3**, a block diagram of an airside system **300** is shown, according to an exemplary embodiment. In various embodiments, airside system **300** can supplement or replace airside system **130** in HVAC system **100**, or can be implemented separate from HVAC system **100**. When implemented in HVAC system **100**, airside system **300** can include a subset of the HVAC devices in HVAC system **100** (e.g., AHU **106**, VAV units **116**, duct **112**, duct **114**, fans, dampers, etc.) and can be located in or around building **10**. A irside system **300** can operate to heat or cool an airflow provided to building **10** using a heated or chilled fluid provided by waterside system **200**.

[0049] In FIG. **3**, airside system **300** is shown to include an economizer-type air handling unit (AHU) **302**. Economizer-type AHUs vary the amount of outside air and return air used by the air handling unit for heating or cooling. For example, AHU **302** can receive return air **304** from building zone **306** via return air duct **308** and can deliver supply air **310** to building zone **306** via supply air duct **312**. In some embodiments, AHU **302** is a rooftop unit located on the roof of building **10** (e.g., AHU **106** as shown in FIG. **1**) or otherwise positioned to receive both return air **304** and outside air **314**. AHU **302** can be configured to operate exhaust air damper **316**, mixing damper **318**, and outside air damper **320** to control an amount of outside air **314** and return air **304** that combine to form supply air **310**. Any return air **304** that does not pass through mixing damper **318** can be exhausted from AHU **302** through exhaust damper **316** as exhaust air **322**.

[0050] Each of dampers **316-320** can be operated by an actuator. For example, exhaust air damper

316 can be operated by actuator **324**, mixing damper **318** can be operated by actuator **326**, and outside air damper **320** can be operated by actuator **328**. Actuators **324-328** can communicate with an AHU controller **330** via a communications link **332**. Actuators **324-328** can receive control signals from AHU controller **330** and can provide feedback signals to AHU controller **330**. Feedback signals can include, for example, an indication of a current actuator or damper position, an amount of torque or force exerted by the actuator, diagnostic information (e.g., results of diagnostic tests performed by actuators **324-328**), status information, commissioning information, configuration settings, calibration data, and/or other types of information or data that can be collected, stored, or used by actuators **324-328**. AHU controller **330** can be an economizer controller configured to use one or more control algorithms (e.g., state-based algorithms, extremum seeking control (ESC) algorithms, proportional-integral (PI) control algorithms, proportional-integral-derivative (PID) control algorithms, model predictive control (MPC) algorithms, feedback control algorithms, etc.) to control actuators **324-328**.

[0051] Still referring to FIG. **3**, AHU **302** is shown to include a cooling coil **334**, a heating coil **336**, and a fan **338** positioned within supply air duct **312**. Fan **338** can be configured to force supply air **310** through cooling coil **334** and/or heating coil **336** and provide supply air **310** to building zone **306**. AHU controller **330** can communicate with fan **338** via communications link **340** to control a flowrate of supply air **310**. In some embodiments, AHU controller **330** controls an amount of heating or cooling applied to supply air **310** by modulating a speed of fan **338**.

[0052] Cooling coil **334** can receive a chilled fluid from waterside system **200** (e.g., from cold water loop **216**) via piping **342** and can return the chilled fluid to waterside system **200** via piping **344**. Valve **346** can be positioned along piping **342** or piping **344** to control a flowrate of the chilled fluid through cooling coil **334**. In some embodiments, cooling coil **334** includes multiple stages of cooling coils that can be independently activated and deactivated (e.g., by AHU controller **330**, by BMS controller **366**, etc.) to modulate an amount of cooling applied to supply air **310**.

[0053] Heating coil **336** can receive a heated fluid from waterside system **200** (e.g., from hot water loop **214**) via piping **348** and can return the heated fluid to waterside system **200** via piping **350**. Valve **352** can be positioned along piping **348** or piping **350** to control a flowrate of the heated fluid through heating coil **336**. In some embodiments, heating coil **336** includes multiple stages of heating coils that can be independently activated and deactivated (e.g., by AHU controller **330**, by BMS controller **366**, etc.) to modulate an amount of heating applied to supply air **310**.

[0054] Each of valves **346** and **352** can be controlled by an actuator. For example, valve **346** can be controlled by actuator **354** and valve **352** can be controlled by actuator **356**. Actuators **354-356** can communicate with AHU controller **330** via communications links **358-360**. Actuators **354-356** can receive control signals from AHU controller **330** and can provide feedback signals to controller **330**. In some embodiments, AHU controller **330** receives a measurement of the supply air temperature from a temperature sensor **362** positioned in supply air duct **312** (e.g., downstream of cooling coil **334** and/or heating coil **336**). AHU controller **330** can also receive a measurement of the temperature of building zone **306** from a temperature sensor **364** located in building zone **306**.

[0055] In some embodiments, AHU controller **330** operates valves **346** and **352** via actuators **354-356** to modulate an amount of heating or cooling provided to supply air **310** (e.g., to achieve a setpoint temperature for supply air **310** or to maintain the temperature of supply air **310** within a setpoint temperature range). The positions of valves **346** and **352** affect the amount of heating or cooling provided to supply air **310** by cooling coil **334** or heating coil **336** and may correlate with the amount of energy consumed to achieve a desired supply air temperature. AHU controller **330** can control the temperature of supply air **310** and/or building zone **306** by activating or deactivating coils **334-336**, adjusting a speed of fan **338**, or a combination of both.

[0056] Still referring to FIG. **3**, airside system **300** is shown to include a building management system (BMS) controller **366** and a client device **368**. BMS controller **366** can include one or more computer systems (e.g., servers, supervisory controllers, subsystem controllers, etc.) that serve as system level controllers, application or data servers, head nodes, or master controllers for airside system **300**, waterside system **200**, HVAC system **100**, and/or other controllable systems that serve building **10**. BMS controller **366** can communicate with multiple downstream building systems or subsystems (e.g., HVAC system **100**, a security system, a lighting system, waterside system **200**, etc.) via a communications link **370** according to like or disparate protocols (e.g., LON, BACnet, etc.). In various embodiments, AHU controller **330** and BMS controller **366** can be separate (as shown in FIG. **3**) or integrated. In an integrated implementation, AHU controller **330** can be a software module configured for execution by a processor of BMS controller **366**.

[0057] In some embodiments, AHU controller **330** receives information from BMS controller **366** (e.g., commands, setpoints, operating boundaries, etc.) and provides information to BMS controller **366** (e.g., temperature measurements, valve or actuator positions, operating statuses, diagnostics, etc.). For example, AHU controller **330** can provide BMS controller **366** with temperature measurements from temperature sensors **362** and **364**, equipment on/off states, equipment operating capacities, and/or any other information that can be used by BMS controller **366** to monitor or control a variable state or condition within building zone **306**.

[0058] Client device **368** can include one or more human-machine interfaces or client interfaces (e.g., graphical user interfaces, reporting interfaces, text-based computer interfaces, client-facing web services, web servers that provide pages to web clients, etc.) for controlling, viewing, or otherwise interacting with HVAC system **100**, its subsystems, and/or devices. Client device **368** can be a computer workstation, a client terminal, a remote or local interface, or any other type of user interface device. Client device **368** can be a stationary terminal or a mobile device. For example, client device **368** can be a desktop computer, a computer server with a user interface, a laptop computer, a tablet, a smartphone, a PDA, or any other type of mobile or non-mobile device. Client device **368** can communicate with BMS controller **366** and/or AHU controller **330** via communications link **372**.

Building Management System

[0059] Referring now to FIG. **4**, a block diagram of a building management system (BMS) **400** is shown, according to an exemplary embodiment. BMS **400** can be implemented in building **10** to automatically monitor and control various building functions. BMS **400** is shown to include BMS controller **366** and a plurality of building subsystems **428**. Building subsystems **428** are shown to include a building electrical subsystem **434**, an information communication technology (ICT) subsystem **436**, a security subsystem **438**, an HVAC subsystem **440**, a lighting subsystem **442**, a lift/escalators subsystem **432**, and a fire safety subsystem **430**. In various embodiments, building subsystems **428** can include fewer, additional, or alternative subsystems. For example, building subsystems **428** can also or alternatively include a refrigeration subsystem, an advertising or signage subsystem, a cooking subsystem, a vending subsystem, a printer or copy service subsystem, or any other type of building subsystem that uses controllable equipment and/or sensors to monitor or control building **10**. In some embodiments, building subsystems **428** include waterside system **200** and/or airside system **300**, as described with reference to FIGS. **2** and **3**.

[0060] Each of building subsystems **428** can include any number of devices, controllers, and connections for completing its individual functions and control activities. HVAC subsystem **440** can include many of the same components as HVAC system **100**, as described with reference to FIGS. **1-3**. For example, HVAC subsystem **440** can include a chiller, a boiler, any number of air handling units, economizers, field controllers, supervisory controllers, actuators, temperature sensors, and other devices for controlling the temperature, humidity, airflow, or other variable conditions within building **10**. Lighting subsystem **442** can include any number of light fixtures, ballasts, lighting sensors, dimmers, or other devices configured to controllably adjust the amount of light provided to a building space. Security subsystem **438** can include occupancy sensors, video surveillance cameras, digital video recorders, video processing servers, intrusion detection devices, access control devices (e.g., card access, etc.) and servers, or other security-related devices.

[0061] Still referring to FIG. **4**, BMS controller **366** is shown to include a communications interface **407** and a BMS interface **409**. Communications interface **407** can facilitate communications between BMS controller **366** and external applications (e.g., monitoring and reporting applications **422**, enterprise control applications **426**, remote systems and applications **444**, applications residing on client devices **448**, etc.) for allowing user control, monitoring, and adjustment to BMS controller **366** and/or subsystems **428**. Communications interface **407** can also facilitate communications between BMS controller **366** and client devices **448**. BMS interface **409** can facilitate communications between BMS controller **366** and building subsystems **428** (e.g., HVAC, lighting security, lifts, power distribution, business, etc.).

[0062] Interfaces **407**, **409** can be or include wired or wireless communications interfaces (e.g., jacks, antennas, transmitters, receivers, transceivers, wire terminals, etc.) for conducting data communications with building subsystems **428** or other external systems or devices. In various embodiments, communications via interfaces **407**, **409** can be direct (e.g., local wired or wireless communications) or via a communications network **446** (e.g., a WAN, the Internet, a cellular network, etc.). For example, interfaces **407**, **409** can include an Ethernet card and port for sending and receiving data via an Ethernet-based communications link or network. In another example, interfaces **407**, **409** can include a Wi-Fi transceiver for communicating via a wireless communications network. In another example, one or both of interfaces **407**, **409** can include cellular or mobile phone communications transceivers. In one embodiment, communications interface **407** is a power line communications interface and BMS interface **409** is an Ethernet interface. In other embodiments, both communications interface **407** and BMS interface **409** are Ethernet interfaces or are the same Ethernet interface.

[0063] Still referring to FIG. **4**, BMS controller **366** is shown to include a processing circuit **404** including a processor **406** and memory **408**. Processing circuit **404** can be communicably connected to BMS interface **409** and/or communications interface **407** such that processing circuit **404** and the various components thereof can send and receive data via interfaces **407**, **409**. Processor **406** can be implemented as a general purpose processor, an application-specific integrated circuit (ASIC), one or more field-programmable gate arrays (FPGAs), a group of processing components, or other suitable electronic processing components.

[0064] Memory **408** (e.g., memory, memory unit, storage device, etc.) can include one or more devices (e.g., RAM, ROM, Flash memory, hard disk storage, etc.) for storing data and/or computer code for completing or facilitating the various processes, layers and modules described in the present application. Memory **408** can be or include volatile memory or non-volatile memory. Memory **408** can include database components, object code components, script components, or any other type of information structure for supporting the various activities and information structures described in the present application. According to an exemplary embodiment, memory **408** is communicably connected to processor **406** via processing circuit **404** and includes computer code for executing (e.g., by processing circuit **404** and/or processor **406**) one or more processes described herein.

[0065] In some embodiments, BMS controller **366** is implemented within a single computer (e.g., one server, one housing, etc.). In various other embodiments BMS controller **366** can be distributed across multiple servers or computers (e.g., that can exist in distributed locations). Further, while FIG. **4** shows applications **422** and **426** as existing outside of BMS controller **366**, in some embodiments, applications **422** and **426** can be hosted within BMS controller **366** (e.g., within memory **408**).

[0066] Still referring to FIG. **4**, memory **408** is shown to include an enterprise integration layer **410**, an automated measurement and validation (AM & V) layer **412**, a demand response (DR) layer **414**, a fault detection and diagnostics (FDD) layer **416**, an integrated control layer **418**, and a building subsystem integration later **420**. Layers **410-420** can be configured to receive inputs from building subsystems **428** and other data sources, determine optimal control actions for building subsystems **428** based on the inputs, generate control signals based on the optimal control actions, and provide the generated control signals to building subsystems **428**. The following paragraphs describe some of the general functions performed by each of layers **410-420** in BMS **400**.

[0067] Enterprise integration layer **410** can be configured to serve clients or local applications with information and services to support a variety of enterprise-level applications. For example, enterprise control applications **426** can be configured to provide subsystem-spanning control to a graphical user interface (GUI) or to any number of enterprise-level business applications (e.g., accounting systems, user identification systems, etc.). Enterprise control applications **426** can also or alternatively be configured to provide configuration GUIs for configuring BMS controller **366**. In yet other embodiments, enterprise control applications **426** can work with layers **410-420** to optimize building performance (e.g., efficiency, energy use, comfort, or safety) based on inputs received at communications interface **407** and/or BMS interface **409**.

[0068] Building subsystem integration layer **420** can be configured to manage communications between BMS controller **366** and building subsystems **428**. For example, building subsystem integration layer **420** can receive sensor data and input signals from building subsystems **428** and provide output data and control signals to building subsystems **428**. Building subsystem integration layer **420** can also be configured to manage communications between building subsystems **428**. Building subsystem integration layer **420** translate communications (e.g., sensor data, input signals, output signals, etc.) across a plurality of multi-vendor/multi-protocol systems.

[0069] Demand response layer **414** can be configured to optimize resource usage (e.g., electricity use, natural gas use, water use, etc.) and/or the monetary cost of such resource usage in response to satisfy the demand of building **10**. The optimization can be based on time-of-use prices, curtailment signals, energy availability, or other data received from utility providers, distributed energy generation systems **424**, from energy storage **427** (e.g., hot TES **242**, cold TES **244**, etc.), or from other sources. Demand response layer **414** can receive inputs from other layers of BMS controller **366** (e.g., building subsystem integration layer **420**, integrated control layer **418**, etc.). The inputs received from other layers can include environmental or sensor inputs such as temperature, carbon di-oxide levels, relative humidity levels, air quality sensor outputs, occupancy sensor outputs, room schedules, and the like. The inputs can also include inputs such as electrical use (e.g., expressed in kWh), thermal load measurements, pricing information, projected pricing, smoothed pricing, curtailment signals from utilities, and the like.

[0070] According to an exemplary embodiment, demand response layer **414** includes control logic for responding to the data and signals it receives. These responses can include communicating with the control algorithms in integrated control layer **418**, changing control strategies, changing setpoints, or activating/deactivating building equipment or subsystems in a controlled manner. Demand response layer **414** can also include control logic configured to determine when to utilize stored energy. For example, demand response layer **414** can determine to begin using energy from energy storage **427** just prior to the beginning of a peak use hour.

[0071] In some embodiments, demand response layer **414** includes a control module configured to actively initiate control actions (e.g., automatically changing setpoints) which minimize energy costs based on one or more inputs representative of or based on demand (e.g., price, a curtailment signal, a demand level, etc.). In some embodiments, demand response layer **414** uses equipment models to determine an optimal set of control actions. The equipment models can include, for example, thermodynamic models describing the inputs, outputs, and/or functions performed by various sets of building equipment. Equipment models can represent collections of building equipment (e.g., subplants, chiller arrays, etc.) or individual devices (e.g., individual chillers, heaters, pumps, etc.).

[0072] Demand response layer **414** can further include or draw upon one or more demand response policy definitions (e.g., databases, XML files, etc.). The policy definitions can be edited or adjusted by a user (e.g., via a graphical user interface) so that the control actions initiated in response to demand inputs can be tailored for the user's application, desired comfort level, particular building equipment, or based on other concerns. For example, the demand response policy definitions can specify which equipment can be turned on or off in response to particular demand inputs, how long a system or piece of equipment should be turned off, what setpoints can be changed, what the allowable set point adjustment range is, how long to hold a high demand setpoint before returning to a normally scheduled setpoint, how close to approach capacity limits, which equipment modes to utilize, the energy transfer rates (e.g., the maximum rate, an alarm rate, other rate boundary information, etc.) into and out of energy storage devices (e.g., thermal storage tanks, battery banks, etc.), and when to dispatch on-site generation of energy (e.g., via fuel cells, a motor generator set, etc.).

[0073] Integrated control layer **418** can be configured to use the data input or output of building subsystem integration layer **420** and/or demand response layer **414** to make control decisions. Due to the subsystem integration provided by building subsystem integration layer **420**, integrated control layer **418** can integrate control activities of the subsystems **428** such that the subsystems **428** behave as a single integrated supersystem. In an exemplary embodiment, integrated control layer **418** includes control logic that uses inputs and outputs from a plurality of building subsystems to provide greater comfort and energy savings relative to the comfort and energy savings that separate subsystems could provide alone. For example, integrated control layer **418** can be configured to use an input from a first subsystem to make an energy-saving control decision for a second subsystem. Results of these decisions can be communicated back to building subsystem integration layer **420**.

[0074] Integrated control layer **418** is shown to be logically below demand response layer **414**. Integrated control layer **418** can be configured to enhance the effectiveness of demand response layer **414** by enabling building subsystems **428** and their respective control loops to be controlled in coordination with demand response layer **414**. This configuration may advantageously reduce disruptive demand response behavior relative to conventional systems. For example, integrated control layer **418** can be configured to assure that a demand response-driven upward adjustment to the setpoint for chilled water temperature (or another component that directly or indirectly affects temperature) does not result in an increase in fan energy (or other energy used to cool a space) that would result in greater total building energy use than was saved at the chiller.

[0075] Integrated control layer **418** can be configured to provide feedback to demand response layer **414** so that demand response layer **414** checks that constraints (e.g., temperature, lighting levels, etc.) are properly maintained even while demanded load shedding is in progress. The constraints can also include setpoint or sensed boundaries relating to safety, equipment operating limits and performance, comfort, fire codes, electrical codes, energy codes, and the like. Integrated control layer **418** is also logically below fault detection and diagnostics layer **416** and automated measurement and validation layer **412**. Integrated control layer **418** can be configured to provide calculated inputs (e.g., aggregations) to these higher levels based on outputs from more than one building subsystem.

[0076] Automated measurement and validation (AM & V) layer **412** can be configured to verify that control strategies commanded by integrated control layer **418** or demand response layer **414** are working properly (e.g., using data aggregated by AM & V layer **412**, integrated control layer **418**, building subsystem integration layer **420**, FDD layer **416**, or otherwise). The calculations made by AM & V layer **412** can be based on building system energy models and/or equipment models for individual BMS devices or subsystems. For example, AM & V layer **412** can compare a model-predicted output with an actual output from building subsystems **428** to determine an accuracy of the model.

[0077] Fault detection and diagnostics (FDD) layer **416** can be configured to provide ongoing fault detection for building subsystems **428**, building subsystem devices (i.e., building equipment), and control algorithms used by demand response layer **414** and integrated control layer **418**. FDD layer

416 can receive data inputs from integrated control layer **418**, directly from one or more building subsystems or devices, or from another data source. FDD layer **416** can automatically diagnose and respond to detected faults. The responses to detected or diagnosed faults can include providing an alert message to a user, a maintenance scheduling system, or a control algorithm configured to attempt to repair the fault or to work around the fault.

[0078] FDD layer **416** can be configured to output a specific identification of the faulty component or cause of the fault (e.g., loose damper linkage) using detailed subsystem inputs available at building subsystem integration layer **420**. In other exemplary embodiments, FDD layer **416** is configured to provide "fault" events to integrated control layer **418** which executes control strategies and policies in response to the received fault events. According to an exemplary embodiment, FDD layer **416** (or a policy executed by an integrated control engine or business rules engine) can shut down systems or direct control activities around faulty devices or systems to reduce energy waste, extend equipment life, or assure proper control response.

[0079] FDD layer **416** can be configured to store or access a variety of different system data stores (or data points for live data). FDD layer **416** can use some content of the data stores to identify faults at the equipment level (e.g., specific chiller, specific AHU, specific terminal unit, etc.) and other content to identify faults at component or subsystem levels. For example, building subsystems **428** can generate temporal (i.e., time-series) data indicating the performance of BMS **400** and the various components thereof. The data generated by building subsystems **428** can include measured or calculated values that exhibit statistical characteristics and provide information about how the corresponding system or process (e.g., a temperature control process, a flow control process, etc.) is performing in terms of error from its setpoint. These processes can be examined by FDD layer **416** to expose when the system begins to degrade in performance and alert a user to repair the fault before it becomes more severe.

Cloud Server with BMS Data Overview

[0080] Referring now to FIG. **5**, a block diagram of system **500** is shown, according to some embodiments. System **500** is shown to include BMS **400**, cloud server **502**, network **504**, and interface **510**. In some embodiments, system **500** includes some or all of BMS **400** within building **10**, as well as off-premise processing (e.g., cloud server **502**) throughout which the various components communicate therewith over network **504**. In some embodiments, system **500** facilitates the transmission and storage of BMS data within building **10** (e.g. and other buildings, etc.) to an off-premise location, and provides means for processing the BMS data to determine updates (e.g., changes, differences, new equipment, new subsystems, etc.).

[0081] Cloud server **502** may be any processing device located off-premise (e.g., within the cloud, etc.). For example, cloud server **502** is located in a data center in a difference region (e.g., different state) than building **10**. Cloud server **502** can be or include any number of processing devices that are configured to retrieve, store, process, and analyze BMS from BMS **400** and/or other BMS systems from other buildings (not shown). Cloud server **502** is described in greater detail below with reference to FIG. **6**.

[0082] Network **504** can communicatively couple the devices and systems of system **500**. In some embodiments, network **504** is at least one of and/or a combination of a Wi-Fi network, a wired Ethernet network, a ZigBee network, a Bluetooth network, and/or any other wireless network. Network **504** may be a local area network or a wide area network (e.g., the Internet, a building WAN, etc.) and may use a variety of communications protocols (e.g., BACnet, BACnet/IP, BACnet/Ethernet, LON, etc.). Network **504** may include routers, modems, servers, cell towers, satellites, and/or network switches. Network **504** may be a combination of wired and wireless networks.

[0083] Interface **510** may be any type of interface configured to receive information (e.g., updates, notifications, messages, emails, etc.) from cloud server **502**. In some embodiments, a building application is hosted on a user device (e.g., smartphone, tablet, workstation computer, etc.) and the application is configured to facilitate communication between the user (e.g., via touch input, messaging, etc.) and cloud server **502**. Cloud server **502** may be configured to provide updates to interface **510** regarding changes between sets of BMS data that have been received at cloud server **502**.

[0084] Referring now to FIG. **6**, a detailed block diagram of cloud server **502** is shown, according to some embodiments. Cloud server **502** is shown to include processing circuit **602** including a processor **604** and memory **606**. Processing circuit **602** can be communicably connected to communications interface **608** such that processing circuit **602** and the various components thereof can send and receive data via communications interface **608**. Processor **604** can be implemented as a general purpose processor, an application-specific integrated circuit (ASIC), one or more field-programmable gate arrays (FPGAs), a group of processing components, or other suitable electronic processing components.

[0085] Memory **606** (e.g., memory, memory unit, storage device, etc.) can include one or more devices (e.g., RAM, ROM, Flash memory, hard disk storage, etc.) for storing data and/or computer code for completing or facilitating the various processes, layers and modules described in the present application. Memory **606** can be or include volatile memory or non-volatile memory. Memory **606** can include database components, object code components, script components, or any other type of information structure for supporting the various activities and information structures described in the present application. According to an exemplary embodiment, memory **408** is communicably connected to processor **604** via processing circuit **602** and includes computer code for executing (e.g., by processing circuit **404** and/or processor **606**) one or more processes described herein.

[0086] In some embodiments, cloud server **502** is implemented within a single computer (e.g., one server, one housing, etc.). In various other embodiments cloud server **502** can be distributed across multiple servers or computers (e.g., that can exist in distributed locations, that can exist in the same datacenter, etc.). Memory **606** is shown to include data collector **609**, entity manager **610**, BMS difference manager **612** (including difference engine **613**), previous backup data **614**, and interface signal generator **616**.

[0087] Data collector **609** may be configured to receive the BMS backup data from one or more of the servers, devices, and/or components located on premise (e.g., BMS server **506**, network engine **508**, (a)-(n), etc.). In some embodiments, data collector **609** can receive multiple types of data indicative of equipment and systems including the equipment. For example, data collector **609** can receive BACnet object data associated with damper **320**, and, which may further indicate the other components upstream or downstream of damper **320** (e.g., fan **338**, etc.). In some embodiments, cloud server **502** can be configured to parse the received BMS data to determine these relationships, and store these relationships in a database for future processing. This is described in greater detail below. Data collector **609** may be configured to provide the BMS (e.g., or BMS) data to entity manager **610**.

[0088] Entity manager **610** may be configured to receive the BMS backup data in raw form, and perform processing to determine multiple “BMS data properties” associated with the data. In some embodiments, the equipment properties described herein include equipment lists, spaces lists, extension lists, or any combination thereof. In some embodiments, the data can also include the equipment name/type for which the data is associated therewith. For example, entity manager **610** may receive BMS data of airside system **300**, and determine a list of all of the equipment, within airside system (e.g., based on BACnet object properties, etc.), a list of the spaces (e.g., zones, etc.) in which the equipment is located within, and a list of the extensions of the equipment, which may include the relationship/entity data associated with the equipment (e.g., the equipment upstream or downstream from the respective equipment, etc.). Entity manager may be configured to provide the analyzed BMS data to BMS difference manager **612**.

[0089] BMS difference manager **612** may be configured to receive the analyze BMS data and previous sets of BMS backup data (e.g., from previous backup database **614**, etc.) and determine differences (e.g., changes in equipment, deltas between operating data, etc.) between the data sets.

[0090] Interface signal generator **616** may be configured to receive the updates determined by BMS difference manage **612** and facilitate the transmission of the updates to one or more client devices communicably connected to BMS sever **502**. For example, building technicians may have tablets communicably coupled with BMS server **502** (e.g., via network **504**, etc.) that host an application which can communicate with cloud server **502**. For example, the application hosted on a workstation within building **10** displays a notification on interface **510** that **10** new VAV boxes have been added to the airside system **300**, as of the last BMS backup.

[0091] Referring generally to FIGS. **7**A-B, a representation of what can be displayed on interface **510** is shown, according to some embodiments. In some embodiments, some or all of the icons shown within diagrams **700**, **710** can be interacted with via a user (e.g., via a click, touch, etc.). For example, a user can select “view” of BMS backup for Jun. 3, 2021, to view a detailed summary of the BMS data that was provided at that time of receiving the BMS backup on June 3.

[0092] Referring specifically to FIG. **7**A, a diagram **700** showing multiple representations of data sets that may have been parsed from the received backup BMS data, according to some embodiments. Diagram **700** is shown to include “Cloud Hosted Server User Interface” which may represent the information displayed on interface **510**. The information includes multiple BMS backup data sets: including one set from Jun. 3, 2021, one set from May 3, 2021, one set from Apr. 3, 2021, and an initial backup set from Mar. 21, 2021. Each of these data sets may be have been parsed/organized (e.g., by entity manager **610**, etc.) to categorize relationship information, equipment specifications (e.g., equipment type, etc.), entity information, and extension information.

[0093] FIG. **7**A is further shown to include a “Select Backup to Restore” feature. In some embodiments, a user may select to restore the BMS system to a former BMS “instance” where the data for the former BMS instance is stored within cloud server **502**. For example, a user observers that the BMS backup from Jun. 3, 2021 includes 144 VAV boxes, but the technician interacting with interface **510** only wants to have 140 VAV operable in BMS **400**, as is the case according to the BMS data from May 3, 2021. The technician then selects “restore” proximate to BMS backup data for Jun. 3, 2021. Cloud server **502** then provides control signals back to BMS **400** to reconfigure BMS **400** such that it operates substantially similar or identical to how BMS **400** was operating when the BMS backup data for May 3, 2021 was received. This may result in making the 4 additional VAV boxes inoperable.

[0094] Referring now to FIG. **7**B, diagram **710** is shown to include a “Notifications Sent” section. In some embodiments, a user may view emails that have been received and/or text messages that have been received, in regards to updates determined by difference engine **613**. For example, a user receives an email indicating that 4 new VAV boxes have been added to BMS **400**, which is shown in diagram **700** in FIG. **7**A, and which may be determined by difference engine **613**.

BMS Data Backup Processes

[0095] Referring now to FIG. **8**, a flow diagram of a process **800** is shown, according to some embodiments. Process **800** may be performed by any of the processing components described herein. For example, process **800** can be performed by cloud server **502** as described above with reference to FIG. **6**.

[0096] Process **800** is shown to include receiving, via an on premise server, configuration data associated with at least part of the BMS (step **802**) and storing the configuration data within a cloud server communicably coupled with the on premise server (step **804**). In some embodiments, cloud server **502** may store multiple configuration data sets representing operation of the BMS at different time periods. For example, BMS server **506**, is configured (e.g., automatically, manually, etc.) to upload large amounts of BMS data to cloud server **502**.

[0097] Process **800** is shown to include determining, via a difference engine within the cloud server, information including a delta between the configuration data and one or more previous sets of configuration data stored within the cloud server (step **806**). In some embodiments, cloud server **502** can determine one or more equipment that have been added to the BMS. Further, cloud server **502** may be aware of energy costs associated with the equipment (e.g., via a priori knowledge queried from a database, by monitoring the equipment, etc.) and can perform processing to determine and increase/decrease of energy costs based on the new BMS data as compared to an older set of BMS data (e.g., the most recent data set, etc.). These updates can be provided to interface **510** such that one or more building technicians can be aware of changes to the BMS over time.

[0098] Process **800** is shown to include providing, to the on premise server, the information to an interface (step **808**). Cloud server **502** may be communicably coupled with one or more devices within building **10** (e.g., workstations, tablets, etc.) and/or outside building **10** (e.g., smartphones of employees, etc.). As described above, a device including interface **510** may display information received from cloud server **502** regarding updates to BMS **400**, which can be based on the received BMS backup data from BMS server **506**.

[0099] While not shown, process **800**, may also include receiving instructions from interface **510** to restore the BMS to a previous implementation (e.g., one of the BMS data stores previously uploaded to cloud server **502** at a previous time period, etc.) and providing control signals to the BMS such that the BMS operates in accordance with the only configuration data of the BMS.

Configuration of Exemplary Embodiments

[0100] As utilized herein, the terms “approximately,” “about,” “substantially”, and similar terms are intended to have a broad meaning in harmony with the common and accepted usage by those of ordinary skill in the art to which the subject matter of this disclosure pertains. It should be understood by those of skill in the art who review this disclosure that these terms are intended to allow a description of certain features described and claimed without restricting the scope of these features to the precise numerical ranges provided. Accordingly, these terms should be interpreted as indicating that insubstantial or inconsequential modifications or alterations of the subject matter described and claimed are considered to be within the scope of the disclosure as recited in the appended claims.

[0101] It should be noted that the term “exemplary” and variations thereof, as used herein to describe various embodiments, are intended to indicate that such embodiments are possible examples, representations, or illustrations of possible embodiments (and such terms are not intended to connote that such embodiments are necessarily extraordinary or superlative examples).

[0102] The term “coupled” and variations thereof, as used herein, means the joining of two members directly or indirectly to one another. Such joining may be stationary (e.g., permanent or fixed) or moveable (e.g., removable or releasable). Such joining may be achieved with the two members coupled directly to each other, with the two members coupled to each other using a separate intervening member and any additional intermediate members coupled with one another, or with the two members coupled to each other using an intervening member that is integrally formed as a single unitary body with one of the two members. If “coupled” or variations thereof are modified by an additional term (e.g., directly coupled), the generic definition of “coupled” provided above is modified by the plain language meaning of the additional term (e.g., “directly coupled” means the joining of two members without any separate intervening member), resulting in a narrower definition than the generic definition of “coupled” provided above. Such coupling may be mechanical, electrical, or fluidic.

[0103] The term “or,” as used herein, is used in its inclusive sense (and not in its exclusive sense) so that when used to connect a list of elements, the term “or” means one, some, or all of the elements in the list. Conjunctive language such as the phrase “at least one of X, Y, and Z,” unless specifically stated otherwise, is understood to convey that an element may be either X, Y, Z; X and Y; X and Z; Y and Z; or X, Y, and Z (i.e., any combination of X, Y, and Z). Thus, such conjunctive language is not generally intended to imply that certain embodiments require at least one of X, at least one of Y, and at least one of Z to each be present, unless otherwise indicated.

[0104] References herein to the positions of elements (e.g., “top,” “bottom,” “above,” “below”) are merely used to describe the orientation of various elements in the FIGURES. It should be noted that the orientation of various elements may differ according to other exemplary embodiments, and that such variations are intended to be encompassed by the present disclosure.

[0105] The hardware and data processing components used to implement the various processes, operations, illustrative logics, logical blocks, modules and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose single-or multi-chip processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, or, any conventional processor, controller, microcontroller, or state machine. A processor also may be implemented as a combination of computing devices, such as a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. In some embodiments, particular processes and methods may be performed by circuitry that is specific to a given function. The memory (e.g., memory, memory unit, storage device) may include one or more devices (e.g., RAM, ROM, Flash memory, hard disk storage) for storing data and/or computer code for completing or facilitating the various processes, layers and modules described in the present disclosure. The memory may be or include volatile memory or non-volatile memory, and may include database components, object code components, script components, or any other type of information structure for supporting the various activities and information structures described in the present disclosure. According to an exemplary embodiment, the memory is communicably connected to the processor via a processing circuit and includes computer code for executing (e.g., by the processing circuit or the processor) the one or more processes described herein.

[0106] The present disclosure contemplates methods, systems and program products on any machine-readable media for accomplishing various operations. The embodiments of the present disclosure may be implemented using existing computer processors, or by a special purpose computer processor for an appropriate system, incorporated for this or another purpose, or by a hardwired system. Embodiments within the scope of the present disclosure include program products comprising machine-readable media for carrying or having machine-executable instructions or data structures stored thereon. Such machine-readable media can be any available media that can be accessed by a general purpose or special purpose computer or other machine with a processor. By way of example, such machine-readable media can comprise RAM, ROM, EPROM, EEPROM, or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to carry or store desired program code in the form of machine-executable instructions or data structures and which can be accessed by a general purpose or special purpose computer or other machine with a processor. Combinations of the above are also included within the scope of machine-readable media. Machine-executable instructions include, for example, instructions and data which cause a general purpose computer, special purpose computer, or special purpose processing machines to perform a certain function or group of functions.

[0107] Although the figures and description may illustrate a specific order of method steps, the order of such steps may differ from what is depicted and described, unless specified differently above. Also, two or more steps may be performed concurrently or with partial concurrence, unless specified differently above. Such variation may depend, for example, on the software and hardware systems chosen and on designer choice. All such variations are within the scope of the disclosure. Likewise, software implementations of the described methods could be accomplished with standard programming techniques with rule-based logic and other logic to accomplish the various connection steps, processing steps, comparison steps, and decision steps.

[0108] It is important to note that the construction and arrangement of various systems (e.g., system **100**, system **200**, etc.) and methods as shown in the various exemplary embodiments is illustrative only. Additionally, any element disclosed in one embodiment may be incorporated or utilized with any other embodiment disclosed herein. Although only one example of an element from one embodiment that can be incorporated or utilized in another embodiment has been described above, it should be appreciated that other elements of the various embodiments may be incorporated or utilized with any of the other embodiments disclosed herein.

Claims

1. A method for system, the method comprising: receiving, over time via an on premise server, time-varying configuration data associated with at least part of the system; storing, within a cloud server communicable with the on premise server, at a plurality of times, current versions of the time-varying configuration data such that the cloud server stores a plurality of configuration data backups corresponding to the plurality of times; providing an interface comprising selectable options corresponding to the plurality of configuration data backups arranged in a chronological order of the plurality of times associated with the plurality of configuration data backups; receiving, via the interface, instructions to restore the system to a selected backup of the plurality of configuration data backups; and operating building equipment of the system using the selected backup of the plurality of configuration data backups.

2. The method of claim 1, further comprising: determining information comprising a delta comprises: determining, based on the configuration data, one or more equipment that have been added to the system; determining an increase in energy costs resulting from the one or more equipment being added to the system, wherein the information comprises the energy costs.

3. The method of claim 1, further comprising: receiving, via the interface, instructions to restore the system to a previous implementation, the previous implementation based on old configuration data of the system; and providing control signals to the system such that the system operates in accordance with the old configuration data of the system.

4. The method of claim 2, wherein determining the information comprising the delta comprises: categorizing the configuration data such that the configuration data is categorized at least partially into at least one of a list of equipment within the system or a list of spaces within the system or a list of extensions associated with the equipment in the system; and providing the at least one of the list of equipment within the system or the list of spaces within the system or the list of extensions associated with the equipment in the system to the interface, in response to a request received via the interface.

5. The method of claim 1, storing the configuration data within the cloud server communicably coupled with the on premise server comprises: storing a plurality of configuration data sets representing operation of the BMS at different time periods, wherein the plurality of configuration data sets comprise the configuration data and the one or more previous sets of configuration data; and providing the plurality of configuration data sets to the interface such that the interface displays the plurality of configuration data sets in sequential order.

6. The method of claim 2, wherein determining the information comprising the delta comprises determining, based on the configuration data, one or more objects that have been added to the system, wherein the information comprises an updated number of objects within the system.

7. The method of claim 1, comprising providing, to the on premise server, the information to the interface by providing at least one of an email or a text message indicative of a delta between the configuration data and one or more previous sets of configuration data to the interface, in response to a request received via the interface.

8. One or more computer readable media (CRM) for determining updates in a system, the one or more CRM comprising instructions to cause one or more processors to: receive, over time via an on premise server, time-varying configuration data associated with at least part of the system; store, within a cloud server communicable with the on premise server, at a plurality of times, current versions of the time-varying configuration data such that the cloud server stores a plurality of configuration data backups corresponding to the plurality of times; provide an interface comprising selectable options corresponding to the plurality of configuration data backups arranged in a chronological order of the plurality of times associated with the plurality of configuration data backups; receive, via the interface, instructions to restore the system to a selected backup of the plurality of configuration data backups; and operate building equipment of the system using the selected backup of the plurality of configuration data backups.

9. The media of claim 8, wherein the one or more CRM comprises instructions to cause the one or more processors to determine information comprising a delta by determining, based on the configuration data, one or more equipment that have been added to the system; determining an increase in energy costs resulting from the one or more equipment being added to the system, wherein the information comprises the energy costs.

10. The media of claim 8, wherein the one or more CRM comprises instructions to cause the one or more processors to: receive via the interface, instructions to restore the system to a previous implementation, the previous implementation based on old configuration data of the system; and provide control signals to the system such that the system operates in accordance with the old configuration data of the system.

11. The media of claim 9, wherein the information comprising the delta is determined by: categorizing the configuration data such that the configuration data is categorized at least partially into at least one of a list of equipment within the system or a list of spaces within the system or a list of extensions associated with the equipment in the system; and providing the at least one of the list of equipment within the system or the list of spaces within the system or the list of extensions associated with the equipment in the system to the interface, in response to a request received via the interface.

12. The media of claim 9 wherein the one or more CRM comprises instructions to cause the one or more processors to: store the configuration data within the cloud server communicably coupled with the on premise server by: storing a plurality of configuration data sets representing operation of the system at different time periods, wherein the plurality of configuration data sets comprise the configuration data and the one or more previous sets of configuration data; and providing the plurality of configuration data sets to the interface such that the interface displays the plurality of configuration data sets in sequential order.

13. The media of claim 9, wherein the information comprising the delta is determined by determining, based on the configuration data, one or more objects that have been added, wherein the information comprises an updated number of objects.

14. The media of claim 9, wherein the one or more CRM comprises instructions to cause the one or more processors to provide, to the on premise server, the information to the interface by providing at least one of an email or a text message indicative of the delta between the configuration data and one or more previous sets of configuration data to the interface, in response to a request received via the interface.

15. A building platform for determining updates in a building management system (BMS) of the building, the building platform comprising a processing device comprising a processing circuit configured to: receive, over time via an on premise server, time-varying configuration data associated with at least part of the BMS; store, within a cloud server communicable with the on premise server, at a plurality of times, current versions of the time-varying configuration data such that the cloud server stores a plurality of configuration data backups corresponding to the plurality of times; provide an interface comprising selectable options corresponding to the plurality of configuration data backups arranged in a chronological order of the plurality of times associated with the plurality of configuration data backups; receive, via the interface, instructions to restore the BMS to a selected backup of the plurality of configuration data backups; and operate building equipment of the BMS using the selected backup of the plurality of configuration data backups.

16. The building platform of claim 15, further comprising determining information comprising a delta by: determining, based on the configuration data, one or more equipment that have been added to the BMS; determining an increase in energy costs resulting from the one or more equipment being added to the BMS, wherein the information comprises the energy costs.

17. The building platform of claim 15, further comprising determining information comprising a delta by: categorizing the configuration data such that the configuration data is categorized at least partially into at least one of a list of equipment within the BMS or a list of spaces within the BMS or a list of extensions associated with the equipment in the BMS; and providing the at least one of the list of equipment within the BMS or the list of spaces within the BMS or the list of extensions associated with the equipment in the BMS to the interface, in response to a request received via the interface.

18. The building platform of claim 15, wherein storing the configuration data within the cloud server communicably coupled with the on premise server comprises: storing a plurality of configuration data sets representing operation of the BMS at different time periods, wherein the plurality of configuration data sets comprise the configuration data and the one or more previous sets of configuration data; and providing the plurality of configuration data sets to the interface such that the interface displays the plurality of configuration data sets in sequential order.

19. The building platform of claim 15, further comprising determining information comprising a delta by: determining, based on the configuration data, one or more objects that have been added to the BMS, wherein the information comprises an updated number of objects within the BMS.

20. The building platform of claim 15, further comprising providing, to the on premise server, information to the interface by providing at least one of an email or a text message indicative of a delta between the configuration data and one or more previous sets of configuration data to the interface, in response to a request received via the interface.