

TIME-SERIES DATA MANAGEMENT METHOD, APPARATUS, DEVICE, STORAGE MEDIUM, AND PROGRAM PRODUCT

TECHNICAL FIELD

[0001] The present disclosure relates to the field of data processing, and in particular to a time-series data management method, device, apparatus, storage medium, and program product.

BACKGROUND

[0002] Time-series data is a series of data indexed by time dimension, which is typically used to describe measured values of a measured subject at each timestamp within a time range. Analyzing time-series data along with time changes can reveal potential patterns, trends, periodic changes, or anomalies.

[0003] In related art, a large amount of time-series data is often stored in a time-series database, and each time-series data usually includes multiple pieces of measurement point data. Serialization processing is performed on the data information corresponding to the measurement point data along the time-series dimension to obtain a serialization result corresponding to the time-series data. When querying the time-series database based on a query condition, it is necessary to analyze the multiple data information corresponding to the measurement point data in the serialization result to obtain time-series data that matches the query condition.

[0004] However, the data information corresponding to the measurement point data in the serialization result is all processed individually, which occupies a large amount of data. The process of querying time-series data based on the query condition also needs to consume a large amount of memory, resulting in longer query time and lower query efficiency.

SUMMARY

[0005] Embodiments of the present disclosure provide a time-series data management method, device, apparatus, storage medium, and program product, which is capable of merging and encoding multiple pieces of measurement point data based on the data collection type, thereby generating a data encoding result with less redundancy and improving the storage and utilization efficiency of time-series data. The technical solutions are as follows.

[0006] In one aspect, a time-series data management method is provided, and the method includes the following steps.

[0007] Time-series data collected within a historical period is acquired, wherein the time-series data is configured to describe, in a time-series dimension, a change trend of measurement point data corresponding to multiple timestamps within the historical period.

[0008] A data encoding type to be used for encoding the time-series data is determined based on the data collection type of the measurement point data in the time-series data, wherein the data encoding type represents a data type for encoding the time-series data.

[0009] By taking the data encoding type as a data encoding benchmark, a data encoding result corresponding to the time-series data is generated by merging and encoding the measurement point data corresponding to the multiple timestamps, wherein the data encoding benchmark is configured to merge and encode measurement point data with a same data collection type, and the data encoding result is configured to acquire the measurement point data corresponding to the multiple timestamps through a single decoding.

[0010] In another aspect, a time-series data management apparatus is provided, and the apparatus includes an acquisition module, a determination module, and a generation module.

[0011] The acquisition module is configured to acquire time-series data collected within a historical period, wherein the time-series data is configured to describe, in a time-series dimension, a change trend of measurement point data corresponding to multiple timestamps within the historical period.

[0012] The determination module is configured to determine a data encoding type to be used for encoding the time-series data based on the data collection type of the measurement point data in the time-series data, wherein the data encoding type represents a data type for encoding the time-series data.

[0013] The generation module is configured to generate, by taking the data encoding type as a data encoding benchmark, a data encoding result corresponding to the time-series data by merging and encoding the measurement point data corresponding to the multiple timestamps, wherein the data encoding benchmark is configured to merge and encode measurement point data with a same data collection type, and the data encoding result is configured to acquire the measurement point data corresponding to the multiple timestamps through a single decoding.

[0014] In still another aspect, a computer device is provided, the computer device includes a processor and a memory storing at least one instruction, at least one program, code set, or instruction. Wherein the processor, when loading and executing the at least one instruction, at least one program, code set, or instruction, is caused to perform the time-series data management method according to the foregoing aspect.

[0015] In yet still another aspect, a computer-readable storage medium is provided. The computer-readable storage medium stores at least one instruction, at least one program, code set, or instruction. Wherein at least one instruction, at least one program, code set, or instruction, when loaded and executed by a processor, causes the processor to perform the time-series data management method according to the foregoing aspect.

[0016] In a further aspect, a computer program product or computer program is provided. The computer program product or computer program includes computer instructions stored in a computer-readable storage medium. The computer instructions, when read and executed by a processor of a computer device, cause the computer device to perform the time-series data management method according to the foregoing aspect.

[0017] The beneficial effects brought by the technical solutions in the embodiments of the present disclosure at least include the following.

[0018] The data encoding type to be used for encoding the time-series data is determined based on the data collection type of the time-series data collected within the historical period, so as to generate a data encoding result corresponding to the time-series data based on the data encoding type and the multiple pieces of measurement point data in the time-series data. Compared with the process of separately processing the data information of the measurement point data included in the time-series data to realize the storage and analysis of the serialization result, the data encoding type to be used for encoding the time-series data is determined more specifically based on the data collection type, thereby merging and encoding the measurement point data corresponding to multiple timestamps based on the data collection type. The present disclosure generates the data encoding result with less redundancy, not only reducing the data storage amount, but also improving the storage efficiency and the subsequent analysis efficiency of time-series data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] In order to more clearly illustrate the technical solutions in the embodiments of the present disclosure, the accompanying drawings to be used in the description of the embodiments will be briefly introduced below, and it is obvious that the accompanying drawings in the following description are only some of the embodiments of the present disclosure, and other accompanying drawings can be obtained according to these drawings for the people of ordinary skill in the field without making any creative labor.

[0020] Figure 1 is a structural block diagram of a management system according to some embodiments of the present disclosure;

[0021] Figure 2 is a flowchart of a time-series data management method according to some embodiments of the present disclosure;

[0022] Figure 3 is a flowchart of another time-series data management method according to some embodiments of the present disclosure;

[0023] Figure 4 is a flowchart of yet another time-series data management method according to some embodiments of the present disclosure;

[0024] Figure 5 is a flowchart of still another time-series data management method according to some embodiments of the present disclosure;

[0025] Figure 6 is a schematic diagram of generating a data encoding result according to some embodiments of the present disclosure;

[0026] Figure 7 is a schematic diagram of generating a data encoding result where the data encoding type is integer type according to some embodiments of the present disclosure;

[0027] Figure 8 is a schematic diagram of data query after encoding the time-series data with the integer type as the data encoding type according to some embodiments of the present disclosure;

[0028] Figure 9 is a schematic diagram of generating a data encoding result where the data encoding type is floating-point type according to some embodiments of the present disclosure;

[0029] Figure 10 is a schematic diagram of data query after encoding time-series data with the floating-point type as the data encoding type according to some embodiments of the present disclosure;

[0030] Figure 11 is a schematic diagram of generating a data encoding result where the data encoding type is string type according to some embodiments of the present disclosure;

[0031] Figure 12 is a schematic diagram of multiple pieces of information included in a data encoding result according to some embodiments of the present disclosure;

[0032] Figure 13 is a structural block diagram of a time-series data management apparatus according to some embodiments of the present disclosure; and

[0033] Figure 14 is a structural block diagram of a server according to some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0034] To present the object, technical solutions, and advantages of the present disclosure more clearly, the embodiments of the present disclosure are described in further detail with reference

to the accompanying drawings.

[0035] In related art, a large amount of time-series data is often stored in a time-series database, and each time-series data usually includes multiple pieces of measurement point data. Serialization processing is performed on the data information corresponding to the measurement point data along the time-series dimension to obtain a serialization result corresponding to the time-series data. When querying the time-series database based on a query condition, it is necessary to analyze the multiple data information corresponding to the measurement point data in the serialization result to obtain time-series data that matches the query condition. However, the data information corresponding to the measurement point data in the serialization result is all processed individually, which occupies a large amount of data. The process of querying time-series data based on the query condition also needs to consume a large amount of memory, resulting in longer query time.

[0036] In some embodiments of the present disclosure, a time-series data management method is described, which is capable of merging and encoding multiple pieces of measurement point data based on the data collection type, thereby generating data encoding results with less redundancy and improving the storage and utilization efficiency of time-series data. The time-series data management method proposed in the embodiments of the present disclosure may be applied in time-series data management within various scenarios in the field of Internet of Things, the financial field, the industrial field, and so on, which is not limited herein.

[0037] It should be noted that the information (including, but not limited to, user device information, user personal information, etc.), data (including, but not limited to, data used for analysis, data stored, data displayed, etc.), and signals involved in the present disclosure are authorized by the user or sufficiently authorized by all parties. The collection, use, and processing of the relevant data need to comply with relevant laws, regulations, and standards of the relevant region. For example, the time-series data, data collection types, and the like involved in the present disclosure are obtained with full authorization.

[0038] To illustrate the management system involved in the embodiments of the present disclosure, the time-series data management method performed by the management system provided in the embodiments of the present disclosure may be performed by a terminal, a server, or interactively by a terminal and a server, and the embodiments of the present disclosure are not limited thereto.

[0039] Referring to FIG. 1, the management system involves a terminal 110, a server 120, and communication interactions between the terminal 110 and the server 120 via a communication network 130.

[0040] In some embodiments, the terminal 110 is configured to acquire time-series data collected within a historical period.

[0041] The time-series data is used to describe, in a time-series dimension, a change trend of multiple pieces of measurement point data corresponding to multiple timestamps within the historical period.

[0042] The historical period is a preset time period. The time-series data includes, for example, wind power data (such as wind speed, power generation) and hydropower data (such as water volume, power generation). The time-series data includes measurement point data collected at multiple timestamps. That is, the time-series data includes multiple pieces of measurement point data with multiple timestamps arranged in the time-series dimension. Therefore, the multiple pieces of measurement point data arranged along the time-series dimension are capable of reflecting the change trend.

[0043] In some embodiments, the terminal 110 sends the time-series data to the server 120 via a communication network 130, and the server 120 analyzes the time-series data.

[0044] In some embodiments, the server 120 determines a data encoding type to be used for encoding the time-series data based on a data collection type of the measurement point data in the time-series data.

[0045] The data encoding type represents a data type for encoding the time-series data.

[0046] The data collection type of the measurement point data represents the type of collected measurement point data. The data collection type may be wind speed, rotational speed, power generation, temperature, and the like, without limitation herein.

[0047] The data collection type aids in determining the data encoding type to be used when encoding the time-series data. The data encoding type may be an integer type, a floating point type, a string type, and the like.

[0048] In some embodiments, the server 120 merges and encodes the measurement point data corresponding to multiple timestamps by using the data encoding type as a data encoding benchmark, to generate a data encoding result corresponding to the time-series data.

[0049] The data encoding benchmark is configured to merge and encode measurement point data of the same data collection type, and the data encoding result is configured to acquire the measurement point data corresponding to the multiple timestamps through a single decoding.

[0050] In some embodiments, the server 120 sends the data encoding result to other terminals (e.g., the terminal 140 that needs to acquire the measurement point data) via the communication network 130, and the terminal 140 receives and decodes the data encoding result to acquire the measurement point data.

[0051] The above terminals includes, but are not limited to, a variety of energy equipment such as wind power generation equipment, hydro power generation equipment, solar power generation equipment, meteorological data detection equipment, hydrogen power generation a, and the like; they may also include an edge device (such as a sensor, a gateway, and the like); and they may also include mobile terminals such as a cellular phone, a tablet computer, a portable laptop computer, an intelligent voice interaction device, an intelligent home appliance, and an in-vehicle terminal, and the like, which may also be realized as a desktop computer. The above server may be an independent physical server, a server cluster, or a distributed system composed of multiple physical servers, or a cloud server providing basic cloud computing services, which is not limited herein.

[0052] In combination with the above introduction and application scenarios, the time-series data management method provided by the present disclosure is described. Taking the method applied to energy equipment as an example, as shown in Figure 2, the method includes the following steps 210 to 230.

[0053] In step 210, time-series data collected during a historical period are acquired.

[0054] The historical period is a predetermined time period that has already passed. For example, the historical period is the past day, the past week, the past month, etc.; or, the current time is 10:09, and the historical period is from 08:00 to 10:00, etc., which is not limited here.

[0055] The time-series data is configured to describe, in a time-series dimension, a change trend of measurement point data corresponding to multiple timestamps within the historical period.

[0056] The historical period includes multiple timestamps, and the multiple timestamps are arranged in the time-series dimension according to the time-series development in the historical period. For example, the multiple timestamps are arranged in the time-series dimension as: timestamp 1, timestamp 2, timestamp 3, etc.

[0057] In some embodiments, the time-series data includes multiple pieces of measurement point data. The measurement point data is the collected data representing the data measurement at each timestamp.

[0058] Illustratively, the measurement point data is energy data collected by energy equipment. For example, the measurement point data is at least one of various types of data, such as wind

speed data and power generation data collected by wind power generation equipment; or, the measurement point data is at least one of various types of data, such as water flow speed data and power generation data collected by hydropower generation equipment.

[0059] Illustratively, each of the multiple timestamps corresponds to at least one piece of measurement point data. For example, the measurement point data corresponding to timestamp 1 is wind speed data A1, and the measurement point data corresponding to timestamp 2 is wind speed data A2; or, the measurement point data corresponding to timestamp 1 is power generation data B1, and the measurement point data corresponding to timestamp 2 is power generation data B2; or, the measurement point data corresponding to timestamp 1 includes wind speed data A1 and power generation data B1, and the measurement point data corresponding to timestamp 2 includes wind speed data A2 and power generation data B2.

[0060] In step 220, a data encoding type to be used for encoding the time-series data is determined based on a data collection type of the measurement point data in the time-series data.

[0061] The data collection type represents the type of the collected measurement point data, and is usually a type defined based on different measurement objectives and application requirements. Each measurement point data usually corresponds to one data collection type. For example, the data collection type is wind speed type; or, the data collection type is rotational speed; or, the data collection type is power generation; or, the data collection type is temperature; or, the data collection type is humidity; or, the data collection type is pressure; or, the data collection type is light intensity, etc., which is not limited here.

[0062] In some embodiments, the data collection type of the measurement point data in the time-series data is determined, and type information and quantity information of the data collection type indicated by the measurement point data are analyzed.

[0063] If the measurement point data corresponding to the multiple timestamps are all wind speed data, it indicates that the data collection type of the measurement point data is "wind speed type" and the quantity is 1; if the measurement point data corresponding to the multiple timestamps include wind speed data and power generation data, it indicates that the data collection type of the measurement point data is "wind speed type" and "power generation type" and the quantity is 2.

[0064] In some embodiments, the data encoding type to be used for encoding the time-series data is determined according to the data collection type.

[0065] The data encoding type represents the data type for encoding the time-series data. Illustratively, according to the data collection type represented by the measurement point data,

the data encoding type is adopted to encode the measurement point data in the time-series data, so as to encode the time-series data; or, for different data collection types, the data encoding types are adopted to encode the measurement point data in the time-series data.

[0066] The data type refers to a category used in computer programming to describe the nature, structure, representation method, and executable operations of measurement point data. The storage form and processing operation form of the measurement point data can be specifically defined through the data type. Different data types have different characteristics and purposes, thus determining the value range, occupied memory space, and executable operations of the measurement point data.

[0067] In some embodiments, the representation form of the measurement point data is determined according to the data collection type of the measurement point data, and then the corresponding data type is selected as the data encoding type based on the data collection type.

[0068] For example, if the data collection type is "wind speed type", considering that the measurement point data of the "wind speed type" is usually implemented in the form of an integer or a decimal, the floating-point type is selected as the data encoding type; if the data collection type includes "wind speed type" and "power generation type", considering that the measurement point data of the "wind speed type" and the measurement point data of the "power generation type" are usually implemented in the form of an integer or a decimal, the floating-point type is selected as the data encoding type; or, if the data collection type is "light intensity type", considering that the measurement point data of the "light intensity type" is usually selected in the form of an integer, the integer type is selected as the data encoding type.

[0069] In step 230, the data encoding type is taken as a data encoding benchmark, and a data encoding result corresponding to the time-series data is generated by merging and encoding the measurement point data corresponding to the multiple timestamps.

[0070] After determining the data encoding type to be used for encoding the time-series data, the data encoding type serves as the data encoding benchmark, and the data encoding benchmark is configured to merge and encode the measurement point data of the same data collection type.

[0071] In some embodiments, after taking the data encoding type as the data encoding benchmark, under the condition that the data encoding type remains unchanged, the measurement point data corresponding to the multiple timestamps are analyzed, and the measurement point data of the same data collection type at different timestamps are determined; then, the measurement point data of the same data collection type at the multiple timestamps

are merged and encoded to generate the data encoding result corresponding to the time-series data.

[0072] For example, if the data encoding type is floating-point type, under the condition that the floating-point type remains unchanged, if the measurement point data corresponding to the multiple timestamps are all wind speed data of "wind speed type", the wind speed data corresponding to the multiple timestamps are determined, and the multiple wind speed data are merged and encoded, so as to obtain the data encoding result encoded by the multiple wind speed data and the data encoding benchmark.

[0073] Alternatively, if the data encoding type is floating-point type, under the condition that the floating-point type remains unchanged, if the measurement point data corresponding to the multiple timestamps include wind speed data of "wind speed type" and power generation data of "power generation type", the wind speed data corresponding to the multiple timestamps are determined, and the multiple piece of wind speed data are merged and encoded; the power generation data corresponding to the multiple timestamps are determined, and the multiple piece of power generation data are merged and encoded; then, the two results as merged and encoded are aggregated to obtain the data encoding result corresponding to the time-series data.

[0074] The data encoding result is configured to acquire the measurement point data corresponding to the multiple timestamps through a single decoding.

[0075] Illustratively, the data encoding result includes measurement point data corresponding to multiple timestamps. By decoding the data encoding result, the measurement point data of the same data collection type corresponding to the multiple timestamps may be acquired.

[0076] It should be noted that the above is only a schematic example, and the embodiments of the present disclosure are not limited thereto.

[0077] In summary, compared with the process of separately processing the data information of the measurement point data included in the time-series data to realize the storage and analysis of the serialization result, the data encoding type to be used for encoding the time-series data is determined more specifically based on the data collection type, thereby merging and encoding the measurement point data corresponding to multiple timestamps based on the data collection type. The present disclosure generates the data encoding result with less redundancy, not only reducing the data storage amount, but also improving the storage efficiency and the subsequent analysis efficiency of time-series data.

[0078] In some embodiments, when multiple pieces of measurement point data in the time-series data indicate the same data collection type, the data encoding type to be used for encoding

the time-series data is determined based on the data meaning represented by the data collection type. Illustratively, as shown in Figure 3, the embodiments shown in Figure 2 above can also be implemented as the following steps 310 to 350, where step 220 can be implemented as the following step 320, and step 230 can be implemented as the following steps 330 to 350.

[0079] In step 310, time-series data collected during a historical period are acquired.

[0080] The historical period is a predetermined time period that has already passed. The time-series data describes, in a time-series dimension, a change trend of measurement point data corresponding to multiple timestamps within the historical period.

[0081] In some embodiments, the measurement point data is log data detected by the terminal. For example, the terminal detects the operation status of a program in real-time or periodically, there are multiple timestamps within the detected historical period, and each timestamp corresponds to measurement point data. The change trend of the measurement point data is determined by comprehensively analyzing the multiple timestamps.

[0082] Illustratively, the measurement point data is energy data collected by energy equipment. For example, the measurement point data is at least one of various types of data, such as wind speed data and power generation data collected by wind power generation equipment; or, the measurement point data is at least one of various types of data, such as water flow speed data and power generation data collected by hydropower generation equipment.

[0083] The time-series data is a collection of measurement point data collected by the first device within the historical period, where the measurement point data represents the results collected by the first device at each timestamp within the historical period. Each of the multiple timestamps corresponds to at least one piece of measurement point data.

[0084] For example, the first device is a wind power generation equipment (referred to as “wind turbine”). As shown in Table 1, the time-series data is a collection of measurement point data collected by wind turbine F within the historical period, and the historical period includes Timestamp 1 and Timestamp 2.

Table 1: Time-series data of wind turbine F

Historical Period	Rotational Speed
Timestamp 1	A1
Timestamp 2	A2

[0085] The measurement point data corresponding to Timestamp 1 is Rotational Speed A1; the measurement point data corresponding to Timestamp 2 is Rotational Speed A2. That is, the time-series data collected within the historical period shown in Table 1 includes two pieces of

measurement point data. Therefore, based on the change trends of Rotational Speeds A1 and A2 in the time-series dimension, the variation of the rotational speed can be determined.

[0086] In step 320, in the case that the measurement point data in the time-series data indicates the same data collection type, the data encoding type to be used for encoding the time-series data is selected from at least two data types based on the data meaning represented by the data collection type.

[0087] The time-series data includes multiple pieces of measurement point data, and each timestamp corresponds to at least one piece of measurement point data. Optionally, the data collection types corresponding to the multiple pieces of measurement point data in the time-series data are determined, and each measurement point data usually corresponds to one data collection type. The data collection type represents the type of the collected measurement point data, and is usually a type defined based on different measurement objectives and application requirements.

[0088] As shown in Table 1, the data collection types of 2 pieces of measurement point data included in the time-series data are both rotational speed types, indicating these 2 pieces of measurement point data are collected by wind turbine F in the rotational speed perspective.

[0089] In some embodiments, the data collection types corresponding to the multiple pieces of measurement point data are determined. If the multiple pieces of measurement point data indicate the same data collection type, the data encoding type is selected based on the data meaning represented by the data collection type.

[0090] The data meaning indicates the presentation mode of the measurement point data of the data collection type. The at least two data types are predefined, including at least two of various data types such as integer type, floating-point type, string type, boolean type, and custom type. The data encoding type is selected based on the data meaning represented by the data collection type to encode the measurement point data in the time-series data.

[0091] In some embodiments, in the case that the data collection type represents that the measurement point data is represented by an integer, the integer type is selected from the at least two data types as the data encoding type.

[0092] Illustratively, if the same data collection type indicated by the multiple pieces of measurement point data is the "counting type", since the data meaning of the counting type usually represents the current running times, cumulative times, etc., the measurement point data presented in the "counting type" is usually in integer form. Therefore, the "integer type" is selected as the data encoding type from the at least two data types. For example, if the measurement point data represents the number of times the device has detected an abnormal

condition at the current timestamp, since the number of times is usually in integer form, the "integer type" is selected as the data encoding type from the at least two data types. That is, the integer type is usually used to characterize data of integer types, such as quantity, counting, and status codes.

[0093] In some embodiments, in the case where the data collection type represents that the measurement point data is represented by an integer, based on the data value range corresponding to the data collection type, the integer type corresponding to the data value range is selected, as the data encoding type, from the at least two data types.

[0094] The data value range represents the value range of the measurement point data of the data collection type. For example, the value of the measurement point data of the counting type usually ranges from 0 to 10 times (e.g., a warning is issued and reset to zero after 10 times). Then the data value range is (0, 10).

[0095] In some embodiments, in the case where the data collection type represents that the measurement point data is represented by an integer, if the data collection type corresponds to a first data value range, a first integer type corresponding to the first data value range is selected as the data encoding type from the at least two data types. If the data collection type corresponds to a second data value range, a second integer type corresponding to the second data value range is selected as the data encoding type from the at least two data types.

[0096] The first data value range is different from the second data value range, and the first integer type and the second integer type usually represent the data presentation forms running on different operating systems.

[0097] Illustratively, the first integer type is int32, and the second integer type is int64. The first data value range corresponding to the first integer type is from -231 to 231-1; the second data value range corresponding to the second integer type is from -263 to 263-1.

[0098] In some embodiments, in the case where the data collection type represents that the measurement point data is represented by a decimal, the floating-point type is selected from the at least two data types as the data encoding type.

[0099] Illustratively, if the same data collection type indicated by the multiple pieces of measurement point data is the "rotational speed type", since the data meaning of the rotational speed type usually represents the rotational speed of the equipment or the rotational speed of equipment components, the measurement point data presented in the "rotational speed type" is usually in decimal form. Therefore, the "floating-point type" is selected as the data encoding type from the at least two data types. The floating-point type is usually used to characterize data that needs to represent decimal parts and has certain precision requirements.

[00100] In some embodiments, in the case where the data collection type represents that the measurement point data is represented by a decimal, the floating-point type corresponding to the data precision is selected, as the data encoding type, from the at least two data types based on the data precision corresponding to the data collection type.

[00101] The data precision is used to represent the number of decimal places in data analysis. For example, the larger the number of decimal places, the higher the data precision, the smaller the number of decimal places, the lower the data precision.

[00102] Optionally, in the case where the data collection type characterizes the measurement point data is represented by a decimal, if the data collection type corresponds to a first data precision, a first floating-point type corresponding to the first data precision is selected from the at least two data types as the data encoding type; if the data collection type corresponds to a second data precision, a second floating-point type corresponding to the second data precision is selected from the at least two data types as the data encoding type.

[00103] The first data precision is different from the second data precision, and the first floating-point type is different from the second floating-point type. For example, the second data precision is higher than the first data precision. The second floating-point type corresponding to the second data precision is float 64, and the second data precision is usually about 15-16 significant digits (with relatively more decimal places). The first floating-point type corresponding to the first data precision is float 32, and the first data precision is usually about 7 significant digits (with relatively fewer decimal places).

[00104] In some embodiments, in the case where the data collection type characterizes that the measurement point data is represented by a string, the string type is selected from the at least two data types as the data encoding type.

[00105] Illustratively, if the same data collection type indicated by the multiple pieces of measurement point data is the "equipment status type", since the data meaning of the equipment status type usually represents the equipment operation status (e.g., normal, faulty, stopped, running), the measurement point data presented in the "equipment status type" is usually descriptive and textual information. Therefore, the "string type" is selected from the at least two data types as the data encoding type. That is, the "string type" is usually used to characterize descriptive and categorical text content.

[00106] It should be noted that the above are only illustrative examples, and the embodiments of the present disclosure are not limited thereto.

[00107] In step 330, for a j^{th} measurement point data among the multiple pieces of measurement point data, a first data array is formed with a j^{th} timestamp corresponding to the j^{th} measurement

point data and the j^{th} measurement point data, so as to acquire first data arrays corresponding to the multiple timestamps, j being a positive integer.

[00108] The time-series data includes multiple pieces of measurement point data, and each timestamp corresponds to at least one piece of measurement point data. If the multiple pieces of measurement point data indicate the same data collection type, the measurement point data corresponding to each timestamp is of the same data collection type. Since the measurement point data under a timestamp represents the data information collected at a certain moment, each timestamp usually corresponds to one piece of measurement point data. For example, the rotational speed data under Timestamp 1 is A1.

[00109] The j^{th} timestamp is any one of the multiple timestamps, and the measurement point data corresponding to the j^{th} timestamp is the j^{th} measurement point data. The j^{th} timestamp and the j^{th} measurement point data are combined to obtain the first data array, and the multiple timestamps and the corresponding measurement point data are combined to acquire the first data arrays corresponding to the multiple timestamps.

[00110] Optionally, taking the j^{th} timestamp and the corresponding j^{th} measurement point data as an example, the j^{th} measurement point data is concatenated after the j^{th} timestamp to obtain the first data array corresponding to the j^{th} timestamp, and the first data arrays corresponding to the multiple timestamps are further obtained.

[00111] In step 340, a second data array is acquired by concatenating the first data arrays corresponding to the multiple timestamps along the time-series dimension.

[00112] The multiple timestamps are determined within the historical period in the time-series dimension, and are arranged in sequence. Since each timestamp corresponds to a first data array, the multiple first data arrays can be arranged based on the order of the multiple timestamps. Then, the first data arrays corresponding to the multiple timestamps are concatenated to obtain the second data array. The second data array represents the merged and encoded result of the multiple pieces of measurement point data of the same data collection type.

[00113] In step 350, the data encoding type is written at a first position serving as the data encoding benchmark, and the second data array is written at a second position after the first position, to generate the data encoding result corresponding to the time-series data.

[00114] Taking the data encoding benchmark implemented as a character writing position as an example, the first position serves as the data encoding benchmark, the data encoding type is written at the first position, and the concatenated second data array is written at the second position after the first position, so as to acquire the data encoding result corresponding to the time-series data.

[00115] In some embodiments, the first position is a preselected character writing position for encoding. The data encoding type is written at the first position to guide the reading method of the second data array written at the second position after the first position. For example, if the data encoding type is floating-point type, the second data array is the encoding result after merging the measurement point data of the same data collection type, corresponding to multiple timestamps, in decimal form.

[00116] In some embodiments, the device name of the first device that collected the time-series data is acquired, and the device name is written at a third position before the first position, the data encoding type is written at the first position, and the second data array is written at the second position, so as to generate the data encoding result corresponding to the time-series data.

[00117] The device name uniquely represents the first device. The third position is a preselected character writing position for encoding, and the third position is before the first position. The contents written at the third position, the first position, and the second position are combined to generate the data encoding result corresponding to the time-series data.

[00118] In some embodiments, the length of the device name, the device name, and the amount of device-collected data of the first device are written at the third position, so as to obtain a device array corresponding to the first device. The length of the type name of the data collection type, the type name, the data encoding type, and the amount of measurement point data corresponding to the data encoding type are written at the first position, so as to obtain a measurement point array corresponding to the data collection type. The second data array is written at the second position. The device array, the measurement point array, and the second data array are concatenated in the order of the third position, the first position, and the second position, so as to obtain the data encoding result corresponding to the time-series data.

[00119] The length of the device name represents the number of characters in the device name (e.g., the length of the device name "Wind Turbine F" is 3). The amount of device-collected data represents the amount of measurement point data collected by the first device. The length of the type name represents the number of characters in the type name of the data collection type (e.g., the length of the type name "Rotational Speed" is 2). The amount of measurement point data represents the amount of measurement point data of the data collection type corresponding to the data encoding type.

[00120] Taking the data encoding processing on the time-series data shown in Table 1 as an example, the length of the device name of Wind Turbine F (3), the device name (Wind Turbine F), and the amount of device-collected data (2) are written at the third position, the device array corresponding to the first device is obtained as: 3—Wind Turbine F—2. The length of the

type name of the data collection type (2), the type name (Rotational Speed), the data encoding type (Floating-Point Type), and the amount of measurement point data corresponding to the data encoding type (2) are written at the first position, the measurement point array corresponding to the data collection type is obtained as: 2——Rotational Speed——Floating-Point Type——2. The second data array is written at the second position as: Timestamp 1——A1——Timestamp 2——A2, thereby acquiring the data encoding result corresponding to the time-series data.

[00121] In some embodiments, the timestamp is a digital representation that marks the collection time of the collected measurement point data. The collection time is the recorded time point when the measurement point data is collected, and there is a preset conversion relationship between timestamps and collection times. In the process of obtaining the second data array, the multiple timestamps are converted into the corresponding collection times based on the conversion relationship, the first data array is acquired based on the timestamps, collection times, and measurement point data, and then the first data arrays corresponding to the multiple timestamps are concatenated in the time-series dimension to obtain the second data array.

[00122] Taking the data encoding processing on the time-series data shown in Table 1 as an example, the device array is: 3——Wind Turbine F——2, the measurement point array is: 2——Rotational Speed——Floating-Point Type——2, and the second data array at the second position is: Timestamp 1——Collection Time 1——A1——Timestamp 2——Collection Time 2——A2, thereby obtaining the data encoding result corresponding to the time-series data shown in Table 1.

[00123] It should be noted that the above is only a schematic example, and the embodiments of the present disclosure are not limited thereto.

[00124] In summary, compared with the process of separately processing the data information of the measurement point data included in the time-series data to realize the storage and analysis of the serialization result, the data encoding type to be used for encoding the time-series data is determined more specifically based on the data collection type, thereby merging and encoding the measurement point data corresponding to multiple timestamps based on the data collection type. The present disclosure generates the data encoding result with less redundancy, not only reducing the data storage amount, but also improving the storage efficiency and the subsequent analysis efficiency of time-series data.

[00125] In the embodiments of the present disclosure, the contents of obtaining the data encoding type when multiple pieces of measurement point data indicate the same data collection

type are introduced. If multiple pieces of measurement point data indicate the same data collection type, the multiple pieces of measurement point data of the same data collection type can be merged and encoded based on the data encoding type to obtain the data encoding result. One data collection type in the data encoding result represents multiple measurement point data, avoiding the cumbersome problem that each measurement point data needs to correspond to a data collection type. In addition, if multiple pieces of measurement point data correspond to the same device name and other information, the multiple pieces of measurement point data of the same information can also be merged and encoded, thereby further reducing the storage amount of the data encoding result and improving the data retrieval efficiency.

[00126] In some embodiments, when multiple pieces of measurement point data in the time-series data indicate different data collection types, at least one data encoding type to be used for encoding the time-series data is determined based on the data meaning represented by the at least two data collection types. Illustratively, as shown in Figure 4, the embodiments shown in Figure 2 above can also be implemented as the following steps 410 to 350, where step 220 can be implemented as the following steps 420 to 440, and step 230 can be implemented as the following step 450.

[00127] In step 410, time-series data collected during a historical period are acquired.

[00128] The historical period is a predetermined time period that has already passed. The time-series data describes, in a time-series dimension, a change trend of measurement point data corresponding to multiple timestamps within the historical period.

[00129] The time-series data is a collection of measurement point data collected by the first device within the historical period. One timestamp corresponds to at least one piece of measurement point data. Since the measurement point data at the timestamp represents the data information collected at a specific moment, if one timestamp corresponds to multiple pieces of measurement point data, the data collection types of these multiple pieces of measurement point data are different. For example, the measurement point data corresponding to Timestamp 1 includes Rotational Speed A1 and Power Generation B1. Whether it is rotational speed or power generation, under a timestamp, usually only a single piece (not multiple pieces) of data is collected.

[00130] For example, the first device is a wind power generation equipment (referred to as: wind turbine). As shown in Table 2, the time-series data is a collection of measurement point data collected by the wind turbine M within the historical period, which includes Timestamp 1, Timestamp 2, and Timestamp 3.

Table 2: Time-series data of wind turbine M

Historical Period	Rotational Speed	Power Generation
Timestamp 1	A1	B1
Timestamp 2	A2	B2
Timestamp 3	A3	B3

[00131] The measurement point data corresponding to Timestamp 1 includes Rotational Speed A1 and Power Generation B1, the measurement point data corresponding to Timestamp 2 includes Rotational Speed A2 and Power Generation B2, and the measurement point data corresponding to Timestamp 3 includes Rotational Speed A3 and Power Generation B3. That is, the time-series data collected within the historical period shown in Table 2 includes six pieces of measurement point data. Based on the change trends of the Rotational Speed A1, the Rotational Speed A2, and the Rotational Speed A3 in the time-series dimension, the variation of rotational speed within the historical period can be determined. Based on the change trends of Power Generation B1, Power Generation B2, and Power Generation B3 in the time-series dimension, the variation of power generation within the historical period can be determined.

[00132] In step 420, in the case that the multiple pieces of measurement point data in the time-series data indicates different data collection types, at least two data collection types are determined.

[00133] The time-series data includes multiple pieces of measurement point data, and each timestamp corresponds to at least one piece of measurement point data. Optionally, the data collection types corresponding to the multiple pieces of measurement point data in the time-series data are determined. The data collection type represents the type of the collected measurement point data, and is usually a type defined based on different measurement objectives and application requirements.

[00134] As shown in Table 2, the time-series data includes 6 pieces of measurement point data. The data collection type of Rotational Speed A1, Rotational Speed A2, and Rotational Speed A3 is "rotational speed type", indicating these 3 pieces of measurement point data are collected by wind turbine F from the rotational speed perspective. The data collection type of Power Generation B1, Power Generation B2, and Power Generation B3 is "power generation type", indicating these 3 pieces of measurement point data are collected by wind turbine F from the power generation perspective.

[00135] In some embodiments, the data collection types corresponding to the multiple pieces of measurement point data are determined. If the multiple pieces of measurement point data

indicate different data collection types, at least two data collection types corresponding to the time-series data are determined.

[00136] As shown in Table 2, the data collection types corresponding to the time-series data include a "rotational speed type" and a "power generation type".

[00137] In step 430, based on data meaning represented by the at least two data collection types, at least one data type is selected from at least two data types as the data encoding type to be used for encoding the time-series data.

[00138] The data meaning indicates the presentation mode of the measurement point data of the data collection type. The at least two data types are predefined, including at least two of various data types such as integer type, floating-point type, string type, boolean type, and custom type. The data encoding type is selected based on the data meaning represented by the data collection type to encode the measurement point data in the time-series data.

[00139] Although there are at least two data collection types, different data collection types may select the same data type as the data encoding type. That is, one data type or more than one data type may be selected as the data encoding type based on the at least two data collection types.

[00140] In some embodiments, in the case that the data collection type represents that the measurement point data is represented by an integer, the integer type is selected from the at least two data types as the data encoding type; in the case that the data collection type represents that the measurement point data is represented by a decimal, the floating-point type is selected from the at least two data types as the data encoding type; in the case that the data collection type represents that the measurement point data is represented by a string, the string type is selected from the at least two data types as the data encoding type.

[00141] In addition, the integer type may further include a first integer type and a second integer type, and the floating-point type may further include a first floating-point type and a second floating-point type. For related content, refer to the description in step 320 above, which is not limited here.

[00142] In some embodiments, in the case that the at least two data collection types all indicate that measurement point data is represented by integers, the integer type is selected as the data encoding type, in the case that the at least two data collection types all indicate that measurement point data is represented by decimals, the floating-point type is selected as the data encoding type. In the case that the at least two data collection types all indicate that measurement point data is represented by strings, the string type is selected as the data encoding type.

[00143] In some embodiments, in the case that the at least two data collection types indicate that measurement point data is represented in different forms, at least two data types are selected as the data encoding types. Illustratively, if data collection type 1 among the at least two data collection types indicates that measurement point data is represented by integers, and data collection type 2 indicates that measurement point data is represented by decimals, the selected at least two data types are integer type and floating-point type. If data collection type 1 indicates that measurement point data is represented by integers, and data collection type 2 indicates that measurement point data is represented by strings, the selected at least two data types are integer type and string type, etc., which is not limited here.

[00144] In step 440, in the case that the at least two data collection types include a first data collection type and a second data collection type, first measurement point data corresponding to the first data collection type and second measurement point data corresponding to the second data collection type are determined from the multiple pieces of measurement point data

[00145] Taking the at least two data collection types implemented as the first data collection type and the second data collection type as an example, the first data collection type is different from the second data collection type.

[00146] The measurement point data of the first data collection type is determined from the multiple pieces of measurement point data in the time-series data and referred to as the first measurement point data, where the multiple pieces of measurement point data include at least one piece of first measurement point data. The measurement point data of the second data collection type is determined from the multiple pieces of measurement point data in the time-series data and referred to as the second measurement point data, where the multiple pieces of measurement point data include at least one piece of second measurement point data.

[00147] In the time-series data shown in Table 2, taking the first data collection type as "Rotational Speed" and the second data collection type as "Power Generation" as an example, the at least one piece of first measurement point data corresponding to the first data collection type determined from the 6 pieces of measurement point data includes Rotational Speed A1, Rotational Speed A2, and Rotational Speed A3. The at least one piece of second measurement point data corresponding to the second data collection type determined from the 6 pieces of measurement point data includes Power Generation B1, Power Generation B2, and Power Generation B3.

[00148] In step 450, taking the first data type corresponding to the first data collection type as the data encoding benchmark, the at least one piece of first measurement point data is merged and encoded to generate a first data encoding result corresponding to the first data collection

type; taking the second data type corresponding to the second data collection type as the data encoding benchmark, the at least one piece of second measurement point data is merged and encoded to generate a second data encoding result corresponding to the second data collection type.

[00149] The first data type is the data encoding type indicated by the first data collection type, and the second data type is the data encoding type indicated by the second data collection type. The first data type and the second data type may be the same (e.g., both are floating-point types) or different (e.g., the first data type is integer type and the second data type is floating-point type), which is not limited here.

[00150] In some embodiments, the first data type is determined based on the first data collection type, so that when merging and encoding measurement point data with the data encoding type as the data encoding benchmark, the first data type is used as the data encoding benchmark to merge and encode the at least one piece of first measurement point data of the first data collection type, so as to generate a first data encoding result corresponding to the first data collection type.

[00151] In some embodiments, for an m^{th} first measurement point data among the multiple pieces of first measurement point data, an m^{th} data array is formed with an m^{th} timestamp corresponding to the m^{th} first measurement point data and the m^{th} first measurement point data, to acquire data arrays corresponding to the first measurement point data, m being a positive integer.

[00152] Illustratively, the m^{th} first measurement point data is any one of the multiple pieces of first measurement point data, and the m^{th} first measurement point data is the first measurement point data corresponding to the m^{th} timestamp. The m^{th} timestamp and the m^{th} first measurement point data are combined to acquire the m^{th} data array. Multiple timestamps and corresponding first measurement point data are combined to acquire the data arrays corresponding to the first measurement point data.

[00153] Taking the m^{th} first measurement point data and the corresponding m^{th} timestamp as an example, the m^{th} first measurement point data is concatenated after the m^{th} timestamp to acquire the m^{th} data array corresponding to the m^{th} first measurement point data, thereby acquiring data arrays respectively corresponding to the first measurement point data.

[00154] In some embodiments, a first-type data array corresponding to the first data collection type is acquired by concatenating the data arrays corresponding to the first measurement point data in the time-series dimension.

[00155] The multiple timestamps are determined within the historical period in the time-series dimension and are arranged in sequence. Since at least one timestamp corresponds to the first measurement point data, the data arrays corresponding to the first measurement point data are arranged based on the arrangement order of the multiple timestamps. Then, the data arrays corresponding to at least one piece of first measurement point data are concatenated to obtain the first-type data array corresponding to the first data collection type.

[00156] The first-type data array describes the merged and encoded result of measurement point data of the first data collection type.

[00157] In some embodiments, the first data type corresponding to the first data collection type is written at a first position serving as the data encoding benchmark, and the first-type data array is written at a second position after the first position, so as to generate the first data encoding result corresponding to the first data collection type.

[00158] Taking the data encoding benchmark implemented as a character writing position as an example, the first position serves as the data encoding benchmark, the first data type is written at the first position, and the concatenated first-type data array is written at the second position after the first position, so as to acquire the first data encoding result corresponding to the first data collection type.

[00159] In some embodiments, the first position is a preselected character writing position for encoding. The first data type is written at the first position to guide the reading method of the first-type data array written at the second position after the first position. For example, if the first data type is floating-point type, the first-type data array is the encoding result after merging at least one piece of first measurement point data of the first data collection type in decimal form.

[00160] In some embodiments, the device name of the first device that collected the time-series data is acquired, and the device name is written at a third position before the first position, the first data type is written at the first position, and the first-type data array is written at the second position, so as to generate the first data encoding result corresponding to the first data collection type.

[00161] The device name uniquely represents the first device. The third position is a preselected character writing position for encoding, and the third position is located before the first position. The contents written at the third position, the first position, and the second position are combined to obtain the first data encoding result corresponding to the first data collection type.

[00162] In some embodiments, the length of the device name, the device name, and the amount of device-collected data of the first device are written at the third position, so as to obtain a

device array corresponding to the first device. The length of the type name of the first data collection type, the type name, the first data type, and the amount of measurement point data corresponding to the first data type are written at the first position, so as to obtain a measurement point array corresponding to the first data collection type. The first-type data array is written at the second position. The device array, the measurement point array, and the first-type data array are concatenated in the order of the third position, the first position, and the second position, so as to obtain the first data encoding result corresponding to the first data collection type.

[00163] Taking the data encoding processing on the time-series data shown in Table 2 where the first data collection type is "rotational speed type" as an example, the length of the device name of Wind Turbine F (3), the device name (Wind Turbine F), and the amount of device-collected data (6) are written at the third position, the device array corresponding to the first device is obtained as: 3—Wind Turbine M—6. The length of the type name of the first data collection type (2), the type name (Rotational Speed), the first data type (Floating-Point Type), and the amount of measurement point data corresponding to the first data type (3) are written at the first position, the measurement point array corresponding to the first data collection type is obtained as: 2—Rotational Speed—Floating-Point Type—3. The first-type data array is written at the second position as: Timestamp 1—A1—Timestamp 2—A2—Timestamp 3—A3, thereby obtaining the first data encoding result corresponding to the first data collection type.

[00164] In some embodiments, there is a preset conversion relationship between timestamps and collection times. In the process of obtaining the first-type data array, the timestamps are converted into corresponding collection times based on the conversion relationship, thereby obtaining the first-type data array including timestamps and collection times in the time-series dimension.

[00165] Taking the data encoding processing on the time-series data shown in Table 2 as an example, the device array is: 3—Wind Turbine F—6, the measurement point array is: 2—Rotational Speed—Floating-Point Type—3, and the first-type data array at the second position is: Timestamp 1—Collection Time 1—A1—Timestamp 2—Collection Time 2—A2—Timestamp 3—Collection Time 3—A3, thereby obtaining the first data encoding result corresponding to the time-series of the first data collection type shown in Table 2.

[00166] In some embodiments, for an n^{th} second measurement point data among the multiple pieces of second measurement point data, an n^{th} data array is formed with an n^{th} timestamp corresponding to the n^{th} second measurement point data and the n^{th} second measurement point

data, to acquire data arrays corresponding to the second measurement point data, n being a positive integer.

[00167] Illustratively, the n^{th} second measurement point data is any one of the multiple pieces of second measurement point data, and the n^{th} second measurement point data is the second measurement point data corresponding to the n^{th} timestamp. The n^{th} timestamp and the n^{th} second measurement point data are combined to acquire the n^{th} data array. Multiple timestamps and corresponding second measurement point data are combined to acquire the data arrays corresponding to the second measurement point data.

[00168] Taking the n^{th} second measurement point data and the corresponding n^{th} timestamp as an example, the n^{th} second measurement point data is concatenated after the n^{th} timestamp to acquire the n^{th} data array corresponding to the n^{th} second measurement point data, thereby acquiring data arrays corresponding to the second measurement point data.

[00169] In some embodiments, a second-type data array corresponding to the second data collection type is acquired by concatenating the data arrays corresponding to the second measurement point data in the time-series dimension.

[00170] The multiple timestamps are determined within the historical period in the time-series dimension and are arranged in sequence. Since at least one timestamp corresponds to the second measurement point data, the data arrays corresponding to the second measurement point data are arranged based on the arrangement order of the multiple timestamps. Then, the data arrays corresponding to at least one piece of second measurement point data are concatenated to obtain the second-type data array corresponding to the second data collection type.

[00171] The second-type data array describes the merged and encoded result of measurement point data of the second data collection type.

[00172] In some embodiments, the second data type corresponding to the second data collection type is written at a first position serving as the data encoding benchmark, and the second-type data array is written at a second position after the first position, so as to generate the second data encoding result corresponding to the second data collection type.

[00173] Taking the data encoding benchmark implemented as a character writing position an example, the first position serves as the data encoding benchmark, the second data type is written at the first position, and the concatenated second-type data array is written at the second position after the first position, so as to acquire the second data encoding result corresponding to the second data collection type.

[00174] In some embodiments, the first position is a preselected character writing position for encoding. The second data type is written at the first position to guide the reading method of

the second-type data array written at the second position after the first position. For example, if the second data type is floating-point type, the second-type data array is the encoding result after merging at least one piece of second measurement point data of the second data collection type in decimal form.

[00175] In some embodiments, the device name of the first device that collected the time-series data is acquired, and the device name is written at a third position before the first position, the second data type is written at the first position, and the second-type data array is written at the second position, so as to generate the second data encoding result corresponding to the second data collection type.

[00176] The device name uniquely represents the first device. The third position is a preselected character writing position for encoding, and the third position is located before the first position. The contents written at the third position, the first position, and the second position are combined to obtain the second data encoding result corresponding to the second data collection type.

[00177] In some embodiments, the length of the device name, the device name, and the amount of device-collected data of the first device are written at the third position, so as to obtain a device array corresponding to the first device. The length of the type name of the second data collection type, the type name, the second data type, and the amount of measurement point data corresponding to the second data type are written at the first position, so as to obtain a measurement point array corresponding to the second data collection type. The second-type data array is written at the second position. The device array, the measurement point array, and the second-type data array are concatenated in the order of the third position, the first position, and the second position, so as to obtain the second data encoding result corresponding to the second data collection type.

[00178] Taking the data encoding processing on the time-series data shown in Table 2 where the second data collection type is "power generation type" as an example, the length of the device name of Wind Turbine F (3), the device name (Wind Turbine F), and the amount of device-collected data (6) are written at the third position, the device array corresponding to the first device is obtained as: 3—Wind Turbine M—6. The length of the type name of the second data collection type (3), the type name (Power Generation), the second data type (Floating-Point Type), and the amount of measurement point data corresponding to the second data type (3) are written at the first position, the measurement point array corresponding to the second data collection type is obtained as: 3—Power Generation—Floating-Point Type—3. The second-type data array is written at the second position as: Timestamp 1—B1—

Timestamp 2——B2——Timestamp 3——B3, thereby obtaining the second data encoding result corresponding to the second data collection type.

[00179] In some embodiments, there is a preset conversion relationship between timestamps and collection times. In the process of obtaining the second-type data array, the timestamps are converted into corresponding collection times based on the conversion relationship, thereby obtaining the second-type data array including timestamps and collection times in the time-series dimension.

[00180] Taking the data encoding processing on the time-series data shown in Table 2 as an example, the device array is: 3——Wind Turbine F——6, the measurement point array is: 3——Power Generation——Floating-Point Type——3, and the second-type data array at the second position is: Timestamp 1——Collection Time 1——B1——Timestamp 2——Collection Time 2——B2——Timestamp 3——Collection Time 3——B3, thereby obtaining the second data encoding result corresponding to the time-series of the second data collection type shown in Table 2.

[00181] The data encoding result corresponding to the time-series data includes the first data encoding result and the second data encoding result. That is, at least one data encoding result is obtained as the corresponding data encoding result based on the number of data collection types.

[00182] It should be noted that the above is only a schematic example, and the embodiments of the present disclosure are not limited thereto.

[00183] In summary, compared with the process of separately processing the data information of the measurement point data included in the time-series data to realize the storage and analysis of the serialization result, the data encoding type to be used for encoding the time-series data is determined more specifically based on the data collection type, thereby merging and encoding the measurement point data corresponding to multiple timestamps based on the data collection type. The present disclosure generates the data encoding result with less redundancy, not only reducing the data storage amount, but also improving the storage efficiency and the subsequent analysis efficiency of time-series data.

[00184] In the embodiments of the present disclosure, the contents of obtaining the data encoding type when multiple pieces of measurement point data indicate different data collection types are introduced. If multiple pieces of measurement point data indicate different data collection types, measurement point data of the same data collection type can be merged and encoded based on the data encoding type, thereby obtaining the data encoding result of the time-series data by integrating data encoding results corresponding to at least two data collection types. By identifying commonalities in the data information of multiple measurement point data

and merging those with partially identical information, the redundant information expression is avoided, data storage volume is reduced, and data retrieval efficiency is improved through the data encoding result corresponding to the time-series data.

[00185] In some embodiments, the above operations are performed for multiple pieces of time-series data in the time-series database to obtain data encoding results respectively corresponding to the multiple pieces of time-series data. Time-series data is stored by using the data encoding results, and also transmitted by the data encoding results. Illustratively, as shown in Figure 5, the embodiments shown in Figure 2 above may further include the following steps 510 to 530.

[00186] In step 510, a time-series database is acquired.

[00187] The time-series database includes multiple pieces of time-series data corresponding to data encoding results. The data encoding result is obtained by merging and encoding measurement point data of the same data collection type corresponding to multiple timestamps.

[00188] Optionally, after acquiring the time-series database, the above data encoding process is performed respectively for the multiple time-series data in the time-series database. Each time-series data includes multiple pieces of measurement point data, and based on the data collection type of the measurement point data in the time-series data, the measurement point data of the same data collection type are merged and encoded to obtain data encoding results corresponding to the multiple pieces of time-series data, respectively.

[00189] As shown in Figure 6, it is a schematic diagram of generating data encoding results. The data encoding type (abbreviated as Value_type, for example) is written at the first position 610 indicated by the first byte, and the data encoding type occupies 1 byte. The second data array composed of timestamps (abbreviated as Timestamp, for example) and measurement point data (abbreviated as value, for example) is written at the second position 620 starting from the second byte. For instance, the timestamp in the second data array occupies 8 bytes, and the number of bytes occupied by the measurement point data is determined based on the measurement point data itself (e.g., the larger the measurement point data, the more bytes it occupies).

[00190] According to different data collection types, different data types are adopted as data encoding types for encoding the measurement point data. The data types include at least one of various types, such as integer types (int, int32, int64), floating-point types (float32, float64), and string types.

[00191] As shown in Figure 7, it is a schematic diagram of generating data encoding results with the integer type as the data encoding type. Taking the integer type as int32 for example, the data encoding type (abbreviated as Value_type, for example) written at the first position 710 indicated by the first byte is the integer type, occupying 1 byte; the second data array composed of timestamps (abbreviated as Timestamp, for example) and measurement point data (abbreviated as value, for example) is written at the second position 720 starting from the second byte. For instance, the timestamp in the second data array occupies 8 bytes, and the measurement point data occupies 4 bytes.

[00192] As shown in Table 3, it is a schematic table of the data query situation after encoding time-series data with the integer type as the data encoding type.

Table 3

Number of data records per query (million)	Number of queries	Average query time before modification	Bytes returned per query before modification	Average query time after modification	Bytes returned per query after modification
1	100	39ms	380,096	19ms	160,000
3	100	140ms	1,157,904	50ms	480,000
5	100	191ms	1,935,678	85ms	800,000

[00193] As shown in Figure 8, it is a schematic diagram of a data query after encoding the time-series data with the integer type as the data encoding type, corresponding to Table 3. Among them, line chart 810 shows a comparison of query time before and after optimization: line 811 (before optimization) indicates the query time without encoding the time-series data, and line 812 (after optimization) indicates the query time after encoding the time-series data. Line chart 820 shows a comparison of query traffic before and after optimization: line 821 (before optimization) indicates the query traffic consumption without encoding the time-series data, and line 822 (after optimization) indicates the query traffic consumption after encoding the time-series data.

[00194] As shown in Figure 9, it is a schematic diagram of generating a data encoding result with the floating-point type as the data encoding type. Taking the floating-point type as float64 for example, the data encoding type (abbreviated as Value_type, for example) written at the first position 910 indicated by the first byte is the floating-point type, occupying 1 byte; the second data array composed of timestamps (abbreviated as Timestamp, for example) and measurement point data (abbreviated as value, for example) is written at the second position 920 starting from the second byte. For instance, the timestamp in the second data array occupies 8 bytes, and the measurement point data occupies 8 bytes (more bytes due to higher precision).

[00195] As shown in Table 4, it is a schematic table of the data query situation after encoding time-series data with the floating-point type as the data encoding type.

Table 4

Number of data records per query (million)	Number of queries	Average query time before modification	Bytes returned per query before modification	Average query time after modification	Bytes returned per query after modification
1	100	85ms	418,051	25ms	160,000
10	100	840ms	4,277,011	278ms	16,000,000
15	100	1.26s	6,470,412	0.432s	24,000,000

[00196] As shown in Figure 10, it is a schematic diagram of a data query after encoding time-series data with the floating-point type as the data encoding type, corresponding to Table 4. Among them, line chart 1010 shows a comparison of query time before and after optimization: line 1011 (before optimization) indicates the query time without encoding the time-series data, and line 1012 (after optimization) indicates the query time after encoding the time-series data. Line chart 1020 shows a comparison of query traffic before and after optimization: line 1021 (before optimization) indicates the query traffic consumption without encoding the time-series data, and line 1022 (after optimization) indicates the query traffic consumption after encoding the time-series data.

[00197] In some embodiments, as shown in Table 5, it is a comparison table of transmission traffic between serialization processing of time-series data and custom encoding processing based on the float64 data type.

Table 5

Data volume	Current byte count	Optimized byte count	Remarks
6,000 records	666,009	210,358	2 devices * 3 measurement points, 1,000 records per measurement point
60,000 records	6,659,253	2,100,358	2 devices * 3 measurement points, 10,000 records per measurement point
600,000 records	59,983,469	21,000,358	2 devices * 3 measurement points, 100,000 records per measurement point

[00198] As shown in Table 5, if serialization processing is performed respectively on multiple pieces of measurement point data in time-series data (6,000 records, 60,000 records, or 600,000 records), the current byte count is relatively large; if the merging and encoding processing is performed on multiple pieces of measurement point data in time-series data, the optimized byte count is relatively small, which reduces data storage volume and reduces data transmission volume.

[00199] As shown in Figure 11, it is a schematic diagram of generating data encoding results when the data encoding type is a string type. The data encoding type (abbreviated as Value_type, for example) written at the first position 1110 indicated by the first byte is the string type, occupying 1 byte; the second data array composed of timestamps (abbreviated as Timestamp, for example), string length (abbreviated as Length, for example), and measurement point data (abbreviated as value, for example) is written at the second position 1120 starting from the second byte. For instance, the timestamp in the second data array occupies 8 bytes, the string length occupies 2 bytes, and the number of bytes occupied by the measurement point data (expressed as a string) is determined based on the measurement point data itself.

[00200] In some embodiments, as shown in Table 6, it is a comparison table of transmission traffic between serialization processing of time-series data and custom encoding processing based on the string type.

Table 6

Data volume	Current byte count	Optimized byte count	Remarks
6,000 records	665,349	209,704	2 devices * 3 measurement points, 1,000 records per measurement point
60,000 records	6,713,349	2,153,704	2 devices * 3 measurement points, 10,000 records per measurement point
600,000 records	67,733,349	22,133,704	2 devices * 3 measurement points, 100,000 records per measurement point

[00201] As shown in Table 6, if serialization processing is performed respectively on multiple pieces of measurement point data in time-series data (6,000 records, 60,000 records, or 600,000 records), the current byte count is relatively large; if the merging and encoding processing is performed on multiple pieces of measurement point data in time-series data, the optimized byte count is relatively small, which reduces data storage volume and reduces data transmission volume.

[00202] It should be noted that the above are only illustrative examples, and the embodiments of the present disclosure are not limited thereto.

[00203] In some embodiments, for the a^{th} time-series data among multiple pieces of time-series data, when multiple pieces of measurement point data in the a^{th} time-series data indicate the same data collection type, a second data array is obtained by merging and encoding the first data arrays corresponding to the multiple pieces of measurement point data in the a^{th} time-series data. Thus, the data encoding type and the second data array are combined to obtain a data encoding result corresponding to the a^{th} time-series data, where a is a positive integer.

[00204] The a^{th} time-series data is any one of the multiple pieces of time-series data. When encoding to obtain the data encoding result corresponding to the a^{th} time-series data, if the multiple pieces of measurement point data in the a^{th} time-series data indicate the same data collection type, the measurement point data corresponding to different timestamps can be merged and encoded based on the data collection type, thereby obtaining the data encoding result corresponding to the a^{th} time-series data, which also corresponds to the data collection type.

[00205] In some embodiments, for the b^{th} time-series data among the multiple pieces of time-series data, when multiple pieces of measurement point data in the b^{th} time-series data indicate different data collection types, the measurement point data respectively corresponding to at least two data collection types is determined. For example, first measurement point data of the first data collection type is determined from the multiple pieces of measurement point data in the b^{th} time-series data, and second measurement point data of the second data collection type is determined from the multiple pieces of measurement point data in the b^{th} time-series data; the data type corresponding to the data collection type is taken as the data encoding benchmark, and data encoding results are obtained respectively corresponding to the at least two data collection types by merging and encoding the measurement point data of the same data collection type, such as a first data encoding result corresponding to the first data collection type and a second data encoding result corresponding to the second data collection type; the data encoding results respectively corresponding to the at least two data collection types are referred as the data encoding result corresponding to the b^{th} time-series data.

[00206] The b^{th} time-series data is any one of the multiple pieces of time-series data. When encoding to obtain the data encoding result corresponding to the b^{th} time-series data, if the multiple measurement point data in the b^{th} time-series data indicate different data collection types, the measurement point data of the same data collection type corresponding to different timestamps can be merged and encoded, thereby obtaining data encoding results respectively corresponding to at least two data collection types, and the at least two data encoding results is used as the data encoding result corresponding to the b^{th} time-series data.

[00207] When the multiple pieces of measurement point data in the time-series data indicate one same data collection type, the data encoding result corresponding to the time-series data is one encoding result corresponding to the data collection type; when the multiple pieces of measurement point data in the time-series data indicate at least two different data collection types, the data encoding result corresponding to the time-series data includes encoding results respectively corresponding to the at least two data collection types.

[00208] The data encoding result is marked with a data tag, and the data tag uniquely indicates the data encoding result.

[00209] When generating the data encoding result corresponding to the time-series data, a data tag corresponding to the data encoding result is generated, and the data encoding result is uniquely indicated by the data tag. Therefore, the data encoding result can also be uniquely determined based on the data tag.

[00210] In the case that the measurement point data in the time-series data indicate the same data collection type, the time-series data corresponds to one data encoding result, and the data encoding result corresponds to a unique data tag. The time-series data can be uniquely determined from multiple pieces of time-series data based on the data tag.

[00211] In the case that the measurement point data in the time-series data indicate different data collection types, the time-series data corresponds to at least two data encoding results, and the at least two data encoding results are in one-to-one correspondence with the at least two data collection types. For example, data collection type 1 corresponds to data encoding result A, and data collection type 2 corresponds to data encoding result B. Each data encoding result corresponds to a unique data tag, such as the data encoding result A corresponding to data tag a and the data encoding result B corresponding to data tag b. The data encoding result can be uniquely determined from multiple data encoding results based on the data tag.

[00212] In step 520, the retrieval information is received.

[00213] The retrieval information is used to select measurement point data of a target data collection type.

[00214] The target data collection type is a preselected type, such as "rotational speed ", "power generation", etc.

[00215] The retrieval information is generated on another terminal based on the target data collection type. For example, the terminal used to collect and manage time-series data is a wind power generation equipment, and another terminal is a mobile phone terminal. The mobile phone terminal displays multiple data collection types. Upon receiving a select operation for the target data collection type among the multiple data collection types, the retrieval information to be sent to the wind power generation equipment is generated based on the target data collection type, so as to obtain measurement point data of the target data collection type from the wind power generation equipment.

[00216] In some embodiments, the retrieval information is used to select measurement point data that meets retrieval conditions, where the retrieval conditions include the target data collection type.

[00217] Illustratively, the retrieval conditions are preselected data retrieval conditions, including at least one of various conditions such as target data collection type, device name, and device type. For example, the retrieval information is used to select measurement point data of "rotational speed type" collected by "Wind Turbine F".

[00218] In step 530, multiple data tags are searched based on the retrieval information, so as to obtain the data encoding result corresponding to the target data collection type as the data retrieval result.

[00219] Based on the fact that one data collection type in one piece of time-series data corresponds to one data encoding result, and each data encoding result corresponds to one data tag; thus, multiple data tags are generated based on multiple pieces of time-series data.

[00220] For example, the time-series database includes time-series data as shown in Table 1 and time-series data as shown in Table 2. The "rotational speed type" of the time-series data shown in Table 1 corresponds to one data encoding result P1 and one data tag p1; the "rotational speed type" of the time-series data shown in Table 2 corresponds to one data encoding result P2 and data tag p2, and the "power generation type" corresponds to one data encoding result P3 and data tag p3. Then the multiple data tags in the time-series database include data tag p1, data tag p2, and data tag p3.

[00221] In some embodiments, the retrieval conditions indicated by the retrieval information is determined, and the data encoding result that meets the retrieval conditions is obtained as the data retrieval result.

[00222] At least one of various information, such as target data collection type, device type, and device name is determined based on the retrieval conditions. If the data encoding result includes at least one of various information, such as data collection type, device type, and device name, multiple data tags can be searched specifically based on the retrieval condition to obtain the data encoding result.

[00223] As shown in Figure 12, it is a schematic diagram of a data encoding result including multiple types of information, which includes a device array 1210, a measurement point array 1220, and a data array 1230. The device array 1210 represents information of the device collecting data, such as: length of the device name (abbreviated as Assetid_cnt), device name (abbreviated as Assetid), and amount of data collected by the device (abbreviated as Assetbytes). The measurement point array 1220 represents type-related information of measurement point data, such as: length of the type name of the data collection type (abbreviated as Pointid_cnt), type name (abbreviated as Pointid), data encoding type (abbreviated as Pointid_value_type), and amount of measurement point data corresponding to the data encoding type (abbreviated

as Pointbytes). The data array 1230 represents information related to measurement point data, such as: timestamp (abbreviated as Timestamp), collection time (abbreviated as Localtime), and value of measurement point data (abbreviated as Value), which is not limited here.

[00224] The target data collection type indicated by the retrieval information is determined, and the data encoding result corresponding to the target data collection type is obtained as the data retrieval result.

[00225] For example, the target data collection type indicated by the retrieval information is "rotational speed type". After searching multiple data tags (data tag p1, data tag p2, and data tag p3), the data encoding results corresponding to the target data collection type include data encoding result P1 corresponding to data tag p1 and data encoding result P2 corresponding to data tag p2. Data encoding result P1 and data encoding result P2 are used as the data retrieval results determined based on the retrieval information.

[00226] The target data collection type and device name indicated by the retrieval information are determined, and the data encoding result corresponding to the target data collection type is obtained as the data retrieval result.

[00227] For example, the target data collection type indicated by the retrieval information is "rotational speed type" and the device name is "Wind Turbine M", that is, the target of the retrieval information is to find measurement point data of "rotational speed type" collected by "Wind Turbine M". After searching multiple data tags (data tag p1, data tag p2, and data tag p3), the data encoding result that meets the target data collection type and device name is data encoding result P2 corresponding to data tag p2. Data encoding result P2 is used as the data retrieval result determined based on the retrieval information..

[00228] The data retrieval result is configured to decode to obtain the measurement point data indicated by the retrieval information.

[00229] Based on the retrieval information sent by another terminal, the data retrieval result is sent to the another terminal, so that the another terminal obtains at least one piece of measurement point data desired by the retrieval information by decoding the data retrieval result.

[00230] Compared with the problem of consuming computing resources, resulting in large data traffic, and time-consuming network transmission due to serialization and deserialization operations on time-series data, time-series data can be stored by data encoding results with smaller resource occupation through the merging and encoding process, which greatly reduces redundant fields (such as fields corresponding to data collection types, fields corresponding to device names, etc.). In addition, the transmission traffic of time-series data can be reduced by transmitting data encoding results, improving data transmission efficiency.

[00231] It should be noted that the above are only illustrative examples, and the embodiments of the present disclosure are not limited thereto.

[00232] In some embodiments, in the process of querying and obtaining measurement point data corresponding to multiple time-series data in the time-series database, metadata query and time-series data query can also be processed separately.

[00233] Metadata is used to describe the data structure, type, source, storage location, relationship, and other information of measurement point data. Metadata query usually does not involve the measurement point data itself, but focuses on information such as the definition, structure, and storage method of measurement point data.

[00234] In some embodiments, when querying measurement point data respectively corresponding to multiple pieces of time-series data in the time-series database, if it is necessary to query information such as the definition, structure, and storage method of measurement point data, considering that the traffic consumed by the metadata query process is small and the query frequency is low, the serialization query method can be used to achieve the purpose of metadata query; if it is necessary to query the measurement point data itself, considering that the transmission traffic of measurement point data is large and the transmission frequency is high, the encoding query method can be used to achieve the purpose of time-series data query, so as to achieve efficient data transmission by transmitting merged and encoded data encoding results.

[00235] It should be noted that the above are only illustrative examples, and the embodiments of the present disclosure are not limited thereto.

[00236] In summary, compared with the process of separately processing the data information of the measurement point data included in the time-series data to realize the storage and analysis of the serialization result, the data encoding type to be used for encoding the time-series data is determined more specifically based on the data collection type, thereby merging and encoding the measurement point data corresponding to multiple timestamps based on the data collection type. The present disclosure generates the data encoding result with less redundancy, not only reducing the data storage amount, but also improving the storage efficiency and the subsequent analysis efficiency of time-series data.

[00237] In the embodiments of the present disclosure, the contents of retrieving and transmitting data encoding results when storing data encoding results are introduced. The data volume of data encoding results is small, making the transmission of data encoding results more efficient. In addition, the terminal sending the retrieval information can quickly decode to obtain time-series data through data encoding results with a small data volume, improving data utilization efficiency while ensuring data integrity.

[00238] FIG. 13 is a structural block diagram of a time-series data management apparatus according to some embodiments of the present disclosure. As shown in FIG. 13, the apparatus includes an acquisition module 1310, a determination module 1320, and a generation module 1330.

[00239] The acquisition module 1310 is configured to: acquire time-series data collected within a historical period, wherein the time-series data is configured to describe, in a time-series dimension, a change trend of measurement point data corresponding to a plurality of timestamps within the historical period.

[00240] The determination module 1320 is configured to: determine a data encoding type to be used for encoding the time-series data based on a data collection type of the measurement point data in the time-series data, wherein the data encoding type represents a data type for encoding the time-series data.

[00241] The generation module 1330 is configured to: generate, by taking the data encoding type as a data encoding benchmark, a data encoding result corresponding to the time-series data by merging and encoding the measurement point data corresponding to the plurality of timestamps, wherein the data encoding benchmark is configured to merge and encode measurement point data with a same data collection type, and the data encoding result is configured to acquire the measurement point data corresponding to the plurality of timestamps through a single decoding.

[00242] In some embodiments, the determination module 1320 is further configured to: in response to the measurement point data in the time-series data indicating the same data collection type, select the data encoding type to be used for encoding the time-series data from at least two data types based on the data meaning represented by the data collection type.

[00243] In some embodiments, the determination module 1320 is further configured to: select an integer type from the at least two data types as the data encoding type in response to the data collection type representing the measurement point data by integers; select a floating-point type from the at least two data types as the data encoding type in response to the data collection type representing the measurement point data by decimals; or select a string type from the at least two data types as the data encoding type in response to the data collection type representing the measurement point data by strings.

[00244] In some embodiments, the generation module 1330 is further configured to: for a j^{th} measurement point data among the measurement point data, form a first data array with a j^{th} timestamp corresponding to the j^{th} measurement point data and the j^{th} measurement point data, to acquire first data arrays corresponding to the plurality of timestamps, j being a positive

integer; acquire a second data array by concatenating the first data arrays corresponding to the plurality of timestamps along the time-series dimension; and write the data encoding type at a first position serving as the data encoding benchmark, and write the second data array at a second position after the first position, to generate the data encoding result corresponding to the time-series data.

[00245] In some embodiments, the determination module 1320 is further configured to: in response to the measurement point data in the time-series data indicating different data collection types, determine at least two data collection types; and select, based on data meanings represented by the at least two data collection types, at least one data type from at least two data types as the data encoding type to be used for encoding the time-series data.

[00246] In some embodiments, the generation module 1330 is further configured to: determine, in response to the at least two data collection types including a first data collection type and a second data collection type, first measurement point data of the first data collection type and second measurement point data of the second data collection type from the measurement point data; and generate, by taking a first data type corresponding to the first data collection type as the data encoding benchmark, a first data encoding result corresponding to the first data collection type based on the first measurement point data, and generate, by taking a second data type corresponding to the second data collection type as the data encoding benchmark, a second data encoding result corresponding to the second data collection type based on the second measurement point data; wherein the data encoding result corresponding to the time-series data includes the first data encoding result and the second data encoding result.

[00247] In some embodiments, the generation module 1330 is further configured to: for an m^{th} first measurement point data among the first measurement point data, form an m^{th} data array with an m^{th} timestamp corresponding to the m^{th} first measurement point data and the m^{th} first measurement point data, to acquire data arrays corresponding to the first measurement point data, m being a positive integer; acquire a first-type data array corresponding to the first data collection type by concatenating the data arrays corresponding to the first measurement point data along the time-series dimension; and write the first data type corresponding to the first data collection type at a first position serving as the data encoding benchmark, and write the first-type data array at a second position after the first position, to generate the first data encoding result corresponding to the first data collection type.

[00248] In some embodiments, the generation module 1330 is further configured to: for an n^{th} second measurement point data among the second measurement point data, form an n^{th} data array with an n^{th} timestamp corresponding to the n^{th} second measurement point data and the n^{th}

second measurement point data, to acquire data arrays corresponding to the second measurement point data, n being a positive integer; acquire a second-type data array corresponding to the second data collection type by concatenating the data arrays corresponding to the second measurement point data along the time-series dimension; and write the second data type corresponding to the second data collection type at a first position serving as the data encoding benchmark, and write the second-type data array at a second position after the first position, to generate the second data encoding result corresponding to the second data collection type.

[00249] In some embodiments, the generation module 1330 is further configured to: acquire a time-series database, wherein the time-series database includes a plurality of time-series data corresponding to data encoding results, the data encoding results are labeled with data tags, and the data tags uniquely indicate the data encoding results; receive retrieval information, wherein the retrieval information is configured to select measurement point data of a target data collection type; search for a plurality of data tags based on the retrieval information, to acquire the data encoding result corresponding to the target data collection type as a data retrieval result.

[00250] In summary, compared with the process of separately processing the data information of the measurement point data included in the time-series data to realize the storage and analysis of the serialization result, the data encoding type to be used for encoding the time-series data is determined more specifically based on the data collection type, thereby merging and encoding the measurement point data corresponding to multiple timestamps based on the data collection type. The present disclosure generates the data encoding result with less redundancy, not only reducing the data storage amount, but also improving the storage efficiency and the subsequent analysis efficiency of time-series data.

[00251] The time-series data management apparatus provided in the above embodiments is merely illustrated by the division of the above functional modules as examples. In practical applications, the above functions can be allocated to different functional modules as needed, that is, dividing the internal structure of the device into different functional modules to complete all or part of the functions described above. In addition, the time-series data management apparatus provided in the above embodiments and the embodiments of the time-series data management method belong to the same concept, and the specific implementation process is detailed in the method embodiments, which will not be repeated here.

[00252] Figure 14 is a structural block diagram of a server according to some embodiments of the present disclosure. The server 1400 includes a central processing unit (CPU) 1401 and a system memory 1402. The system memory 1402 includes a random access memory (RAM)

1403 and a read-only memory (ROM) 1404. The server 1400 also includes a system bus 1405 that connects the system memory 1402 and the central processing unit 1401. In addition, the server 1400 further includes a mass storage device 1406 for storing an operating system 1413, application programs 1414, and other program modules 1415.

[00253] The mass storage device 1406 is connected to the CPU 1401 through a mass storage controller (not shown) connected to the system bus 1405. The mass storage device 1406 and its associated computer-readable media provide non-transitory storage for the server 1400. That is, the mass storage device 1406 may include computer-readable media (not shown) such as a hard disk or a compact disc read-only memory (CD-ROM) drive.

[00254] Without loss of generality, the computer-readable storage medium may include a computer storage medium and a communication medium. The computer storage medium includes transitory and non-transitory, removable and non-removable mediums implemented by any method or technology for storing information such as computer-readable storage instructions, data structures, program modules, or other data. The aforementioned system memory 1402 and mass storage device 1406 may be collectively referred to as memory.

[00255] According to various embodiments of the present disclosure, the server 1400 may also run by connecting to a remote computer on a network such as the Internet. That is, the server 1400 may be connected to the network 1412 through a network interface unit 1411 connected to the system bus 1405; alternatively, the network interface unit 1411 may be used to connect to other types of networks or remote computer systems (not shown).

[00256] The aforementioned memory also includes one or more programs, which are stored in the memory and configured to be executed by the CPU.

[00257] Some embodiments of the present disclosure provide a computer device, the computer device includes a processor and a memory storing at least one instruction, at least one program, code set, or instruction. Wherein the processor, when loading and executing the at least one instruction, at least one program, code set, or instruction, is caused to perform the time-series data management method provided by any one of the above method embodiments.

[00258] Some embodiments of the present disclosure provide a computer-readable storage medium. The computer-readable storage medium stores at least one instruction, at least one program, code set, or instruction. Wherein the at least one instruction, at least one program, code set or instruction, when loaded and executed by a processor, causes the processor to perform the time-series data management method provided by any one of the above method embodiments.

[00259] Some embodiments of the present disclosure provide a computer program product or computer program. The computer program product or computer program includes computer instructions stored in a computer-readable storage medium. The computer instructions, when read and executed by a processor of a computer device, cause the computer device to perform the time-series data management method provided by any one of the above method embodiments.

[00260] The above descriptions are only optional embodiments of the present disclosure, and are not intended to limit the present disclosure. Any modifications, equivalent replacements, improvements, and the like made within the spirit and principles of the present disclosure should be included within the scope of protection of the present disclosure.

CLAIMS

1. A time-series data management method, comprising:

acquiring time-series data collected within a historical period, wherein the time-series data is configured to describe, in a time-series dimension, a change trend of measurement point data corresponding to a plurality of timestamps within the historical period;

determining a data encoding type to be used for encoding the time-series data based on a data collection type of the measurement point data in the time-series data, wherein the data encoding type represents a data type for encoding the time-series data; and

generating, by taking the data encoding type as a data encoding benchmark, a data encoding result corresponding to the time-series data by merging and encoding the measurement point data corresponding to the plurality of timestamps, wherein the data encoding benchmark is configured to merge and encode measurement point data with a same data collection type, and the data encoding result is configured to acquire the measurement point data corresponding to the plurality of timestamps through a single decoding.

2. The method according to claim 1, wherein determining the data encoding type to be used for encoding the time-series data based on the data collection type of the measurement point data in the time-series data comprises:

in response to the measurement point data in the time-series data indicating the same data collection type, selecting the data encoding type to be used for encoding the time-series data from at least two data types based on data meaning represented by the data collection type.

3. The method according to claim 2, wherein selecting the data encoding type to be used for encoding the time-series data from at least two data types based on the data meaning represented by the data collection type comprises any one of:

selecting an integer type from the at least two data types as the data encoding type in response to the data collection type representing the measurement point data by integers;

selecting a floating-point type from the at least two data types as the data encoding type in response to the data collection type representing the measurement point data by decimals; or

selecting a string type from the at least two data types as the data encoding type in response to the data collection type representing the measurement point data by strings.

4. The method according to claim 2, wherein generating, by taking the data encoding type as the data encoding benchmark, the data encoding result corresponding to the time-series data by merging and encoding the measurement point data corresponding to the plurality of timestamps comprises:

for a j^{th} measurement point data among the measurement point data, forming a first data array with a j^{th} timestamp corresponding to the j^{th} measurement point data and the j^{th} measurement point data, to acquire first data arrays corresponding to the plurality of timestamps, j being a positive integer;

acquiring a second data array by concatenating the first data arrays corresponding to the plurality of timestamps along the time-series dimension; and

writing the data encoding type at a first position serving as the data encoding benchmark, and writing the second data array at a second position after the first position, to generate the data encoding result corresponding to the time-series data.

5. The method according to claim 1, wherein determining the data encoding type to be used for encoding the time-series data based on the data collection type of the measurement point data in the time-series data comprises:

in response to the measurement point data in the time-series data indicating different data collection types, determining at least two data collection types; and

selecting, based on data meanings represented by the at least two data collection types, at least one data type from at least two data types as the data encoding type to be used for encoding the time-series data.

6. The method according to claim 5, wherein generating, by taking the data encoding type as the data encoding benchmark, the data encoding result corresponding to the time-series data by merging and encoding the measurement point data corresponding to the plurality of timestamps comprises:

determining, in response to the at least two data collection types comprising a first data collection type and a second data collection type, first measurement point data of the first data collection type and second measurement point data of the second data collection type from the measurement point data; and

generating, by taking a first data type corresponding to the first data collection type as the data encoding benchmark, a first data encoding result corresponding to the first data collection type based on the first measurement point data, and generating, by taking a second data type corresponding to the second data collection type as the data encoding benchmark, a second data encoding result corresponding to the second data collection type based on the second measurement point data;

wherein the data encoding result corresponding to the time-series data comprises the first data encoding result and the second data encoding result.

7. The method according to claim 6, wherein generating, by taking the first data type corresponding to the first data collection type as the data encoding benchmark, the first data encoding result corresponding to the first data collection type based on the first measurement point data comprises:

for an m^{th} first measurement point data among the first measurement point data, forming an m^{th} data array with an m^{th} timestamp corresponding to the m^{th} first measurement point data and the m^{th} first measurement point data, to acquire data arrays corresponding to the first measurement point data, m being a positive integer;

acquiring a first-type data array corresponding to the first data collection type by concatenating the data arrays corresponding to the first measurement point data along the time-series dimension; and

writing the first data type corresponding to the first data collection type at a first position serving as the data encoding benchmark, and writing the first-type data array at a second position after the first position, to generate the first data encoding result corresponding to the first data collection type.

8. The method according to claim 6, wherein generating, by taking the second data type corresponding to the second data collection type as the data encoding benchmark, the second data encoding result corresponding to the second data collection type based on the second measurement point data comprises:

for an n^{th} second measurement point data among the second measurement point data, forming an n^{th} data array with an n^{th} timestamp corresponding to the n^{th} second measurement point data and the n^{th} second measurement point data, to acquire data arrays corresponding to the second measurement point data, n being a positive integer;

acquiring a second-type data array corresponding to the second data collection type by concatenating the data arrays corresponding to the second measurement point data along the time-series dimension; and

writing the second data type corresponding to the second data collection type at a first position serving as the data encoding benchmark, and writing the second-type data array at a second position after the first position, to generate the second data encoding result corresponding to the second data collection type.

9. The method according to any one of claims 1 to 8, wherein after generating the data encoding result corresponding to the time-series data, the method further comprises:

acquiring a time-series database, wherein the time-series database comprises a plurality of time-series data corresponding to data encoding results, the data encoding results are labeled with data tags, and the data tags uniquely indicate the data encoding results;

receiving retrieval information, wherein the retrieval information is configured to select measurement point data of a target data collection type; and

searching for a plurality of data tags based on the retrieval information, to acquire the data encoding result corresponding to the target data collection type as a data retrieval result.

10. A time-series data management apparatus, comprising:

an acquisition module, configured to acquire time-series data collected within a historical period, wherein the time-series data is configured to describe, in a time-series dimension, a change trend of measurement point data corresponding to a plurality of timestamps within the historical period;

a determination module, configured to determine a data encoding type to be used for encoding the time-series data based on a data collection type of the measurement point data in the time-series data, wherein the data encoding type represents a data type for encoding the time-series data; and

a generation module, configured to generate, by taking the data encoding type as a data encoding benchmark, a data encoding result corresponding to the time-series data by merging and encoding the measurement point data corresponding to the plurality of timestamps, wherein the data encoding benchmark is configured to merge and encode measurement point data with a same data collection type, and the data encoding result is configured to acquire the measurement point data corresponding to the plurality of timestamps through a single decoding.

11. A computer device, comprising a processor and a memory storing at least one segment of a program, wherein the processor, when loading and executing the at least one segment of the program, is caused to perform the time-series data management method as defined in any one of claims 1 to 9.

12. A computer-readable storage medium storing at least one segment of a program, wherein the at least one segment of the program, when loaded and executed by a processor, causes the processor to perform the time-series data management method as defined in any one of claims 1 to 9.

13. A computer program product, comprising computer instructions, wherein the computer instructions, when executed by a processor, cause the processor to perform the time-series data management method as defined in any one of claims 1 to 9.