

# **SCHEDULING SCHEME CONFIGURATION METHOD AND APPARATUS, COMPUTER READABLE STORAGE MEDIUM THEREOF AND COMPUTER DEVICE THEREOF**

The present application claims priority to Chinese Patent Application No. 201710631021.7 filed to the SIPO on July 28, 2017 and entitled “SCHEDULING SCHEME CONFIGURATION METHOD AND APPARATUS”, the disclosure of which is hereby incorporated herein by reference in its entirety.

## **Technical Field of the present invention**

The embodiments of the present invention relate to, but are not limited to, the field of computer networks, and in particular to a method and apparatus for configuring a scheduling scheme of access resources, a computer readable storage medium thereof and a computer device thereof.

## **Background of the present invention**

With the development of the Internet, users have higher and higher requirements for the quality of service of network access. Intelligent scheduling systems are widely used in various network systems to improve the access efficiency and enhance the system robustness. As a result, the reference conditions and intelligent algorithms for intelligent traffic scheduling become more complex, and the maintenance cost becomes higher.

The development process of intelligent scheduling can be divided into geographic location and availability based scheduling, quality-of-service based scheduling, optimal cost performance based scheduling or the like, including IP positioning operations, availability calculations, quality-of-service operations, bandwidth cost calculations or the like. Once a certain operational basic data or operational logic fails, the operation of the whole scheduling system will be affected, and the network access throughout the network will be further affected.

## **Summary of the present invention**

The embodiments of the present invention are aimed at solving the problems described

above.

In accordance with a first aspect of the embodiments of the present invention, a scheduling scheme configuration method is provided, including steps of:

performing state verification on each operational dimension involved in the generation of a scheduling scheme; and

when one or more operational dimensions are abnormal, removing the abnormal operational dimension to generate a new scheduling scheme.

Preferably, the method further includes a step of:

configuring multiple operational modes, operational dimensions included in each operational mode being different, the multiple operational modes including a standard operational mode including all operational dimensions and at least one degraded operational mode including some of the operational dimensions.

Preferably, the step of, when one or more operational dimensions are abnormal, removing the abnormal operational dimension to generate a new scheduling scheme includes:

removing, from the standard operational mode, the abnormal operational dimension to obtain a new operational mode; or,

selecting, from the multiple operational modes, a degraded operational mode not including the abnormal operational dimension as an operational mode for further use in the calculation of a scheduling scheme.

Preferably, the multiple operational modes have different weigh values, and a degraded operational mode with a higher weight value is preferentially selected when a degraded operational mode not including the abnormal operational dimension is selected from the multiple operational modes.

Preferably, operational dimensions in each operational mode are sorted in a certain order; an output of the operational dimension sorted at the previous position is used as an input of the current operational dimension, an output of the current operational dimension is used as an input of the operational dimension sorted at the next position, and an initial scheduling scheme is used as an input of the operational dimension sorted at the first position; and, the data format of the input scheduling scheme of each operational dimension is consistent with the data format of the output scheduling scheme.

Preferably, the step of performing state verification on each operational dimension involved in the generation of a scheduling scheme includes:

verifying whether the scheduling scheme output after the operation of each operational dimension is abnormal; and

verifying the timeliness of basic data of each operational dimension, and determining the corresponding operational dimension is abnormal when the timeliness of the basic data exceeds a corresponding failure threshold.

Preferably, the step of verifying whether the scheduling scheme output after the operation of each operational dimension is abnormal includes:

by using the initial scheduling scheme as the input of the operational dimension sorted at the first position and according to the sorting of operational dimensions in the currently used operational mode, sequentially operating the input scheduling scheme to obtain an output scheduling scheme;

comparing the output scheduling scheme with the input scheduling scheme of the same operational dimension; and

when the rate of change of the output scheduling scheme relative to the input scheduling scheme of the same operational dimension exceeds a preset abnormality threshold, determining that the operational dimension is abnormal.

Preferably, after it is determined that an operational dimension is abnormal, the input scheduling scheme of the operational dimension is directly transparently transmitted to an operational dimension sorted at a position next to the operational dimension, as an input scheduling scheme of the operational dimension at the next position.

Preferably, when the currently used operational mode is a degraded operational mode, the method further includes steps of:

performing state verification on each operational dimension in the standard operational mode; and

switching back to the standard operational mode when each operational dimension in the standard operational mode is normal.

In accordance with another aspect of the embodiments of the present invention, a scheduling scheme configuration apparatus is provided, including:

an abnormality detection module configured to perform state verification on each operational dimension involved in the generation of a scheduling scheme; and

a scheme configuration module configured to, when one or more operational dimensions are abnormal, remove the abnormal operational dimension to generate a new scheduling scheme.

Preferably, the apparatus further includes:

an operational mode management module configured to configure multiple operational modes, operational dimensions included in each operational mode being different, the multiple operational modes including a standard operational mode including all operational dimensions and at least one degraded operational mode including some of the operational dimensions.

Preferably, the scheme configuration module includes:

a first configuration unit configured to remove, from the standard operational mode, the abnormal operational dimension to obtain a new operational mode; and

a second configuration unit configured to select, from the multiple operational modes, a degraded operational mode not including the abnormal operational dimension as an operational mode for further use in the calculation of a scheduling scheme.

Preferably, the multiple operational modes have different weight values, and

the second configuration unit is specifically configured to preferentially select a degraded operational mode with a higher weight value when a degraded operational mode not including the abnormal operational dimension is selected from the multiple operational modes.

Preferably, operational dimensions in each operational mode are sorted in a certain order; an output of the operational dimension sorted at the previous position is used as an input of the current operational dimension, an output of the current operational dimension is used as an input of the operational dimension sorted at the next position, and an initial scheduling scheme is used as an input of the operational dimension sorted at the first position; the data format of the input scheduling scheme of each operational dimension is consistent with the data format of the output scheduling scheme; and, the abnormality detection module includes:

a logic verification unit configured to verify whether a scheduling scheme output after the operation of each operational dimension is abnormal; and

a data verification unit configured to verify the timeliness of basic data of each operational dimension, and determine the corresponding operational dimension is abnormal when the

timeliness of the basic data exceeds a corresponding failure threshold.

Preferably, the logic verification unit includes:

an operation subunit configured to, by using the initial scheduling scheme as the input of the operational dimension sorted at the first position and according to the sorting of operational dimensions in the currently used operational mode, sequentially operate the input scheduling scheme to obtain an output scheduling scheme;

a comparison subunit configured to compare the output scheduling scheme with the input scheduling scheme of the same operational dimension; and

a logic abnormality detection subunit configured to determine that the operational dimension is abnormal, when the rate of change of the output scheduling scheme relative to the input scheduling scheme of the same operational dimension exceeds a preset abnormality threshold.

Preferably, the operation subunit is further configured to, after it is determined that an operational dimension is abnormal, directly transparently transmit the input scheduling scheme of the operational dimension to an operational dimension sorted at a position next to the operational dimension, as an input scheduling scheme of the operational dimension at the next position.

Preferably, the abnormality detection module further includes a standard mode detection unit, and the scheme configuration module further includes a third configuration unit;

the standard mode detection unit is configured to perform state verification on each operational dimension in the standard operational mode when the currently used operational mode is a degraded operational mode; and

the third configuration unit is configured to switch back to the standard operational mode when each operational dimension in the standard operational mode is normal.

Another aspect of the embodiments of the present invention provides a computer readable storage medium storing computer programs that, when executed by a processor, implement the steps of the method described above.

Another aspect of the embodiments of the present invention provides a computer device, including a memory, a processor and computer programs that are stored on the memory and runnable on the processor, the processor implementing the steps of the method described above

when executing the programs.

The embodiments of the present invention provide a scheduling scheme configuration and apparatus, in which state verification is performed on operational dimensions involved in the generation of a scheduling scheme; and when one or more operational dimensions are abnormal, the abnormal operational dimension is removed to generate a new scheduling scheme. The discovery and automatic correction of an abnormal operational mode are realized, the normal generation of a scheduling scheme is ensured, and reliable network services are thus ensured. In accordance with the difference comparison of the coverage scheme and the network area-service node mapping table before and after operation and the timeliness of basic data, the automatic detection of the basic data and operational logic of the scheduling operation module is realized; a scheme of controlling the scheduling operation module based on the operational mode is provided; and, a hierarchical scheduling operation system is realized, and the fast isolation of a fault is realized.

Other characteristics, features and advantages of the embodiments of the present invention will become apparent upon reading the following description of exemplary embodiments with reference to the accompanying drawings.

### **Brief Description of the Drawings**

The drawings incorporated into this specification and constituting a part of this specification show the embodiments of the present invention, and are used together with the description to explain the principles of the embodiments of the present invention. Throughout the drawings, similar reference numerals represent similar elements. The drawings to be described hereinafter are some but not all of the embodiments of the present invention. A person of ordinary skill in the art may obtain other drawings according to these drawings without paying any creative effort.

Fig. 1 exemplarily shows a flow of a scheduling scheme configuration method according to Embodiment 1 of the present invention;

Fig. 2 exemplarily shows a flow of the scheduling scheme configuration method according to Embodiment 2 of the present invention;

Fig. 3 exemplarily shows an architecture of a scheduling scheme configuration system

according to Embodiment 3 of the present invention;

Fig. 4 exemplarily shows a structure of a scheme configuration module 302 in Fig. 3;

Fig. 5 exemplarily shows a structure of an abnormality detection module 301 in Fig. 3; and

Fig. 6 exemplarily shows a structure of a logic verification unit 501 in Fig. 5.

### **Detailed Description of the present invention**

To make the objectives, technical solutions and advantages of the embodiments of the present invention clearer, the technical solutions in the embodiments of the present invention will be described clearly and completely with reference to the drawings in the embodiments of the present invention. Apparently, the described embodiments are some but not all of the embodiments of the present invention. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments of the present invention without paying any creative effort shall fall into the protection scope of the embodiments of the present invention. It is to be noted that the embodiments in the present application and the features in the embodiments can be combined in any way if not conflicted.

An existing scheduling scheme generation mechanism includes multiple operational links. Once a certain optional basic datum or optional logic fails, the running of the whole scheduling system will be affected, and the network access throughout the network will be further affected. At present, there is yet no method to discover a fault of the basic data and the operational logic of the scheduling operation module, and the system cannot automatically and quickly perform fault processing on the scheduling operation module with one or more faults in the case of fault occurrence, resulting in a serious delay in the fault discovery and processing, affecting the normal operation of the system and reducing the service efficiency and quality of service of the system.

In order to solve the above problems, the embodiments of the present invention provide a scheduling scheme configuration method and apparatus. Abnormality detection can be performed on operational dimensions involved in a scheduling scheme to timely discover abnormal logic and abnormal basic data, and the abnormal operational dimension can be automatically eliminated, and a guaranteed operation scheme can be generated when the abnormality is not eliminated, to ensure the continuous and normal operation of services.

Embodiment 1 of the present invention will be described below with reference to the accompanying drawings.

This embodiment of the present invention provides a scheduling scheme configuration method. The flow of configuring and adjusting a scheduling scheme by this method is shown in Fig. 1, including the following steps.

Step 101: Multiple operational modes are configured, operational dimensions included in each operational mode being different.

In this step, multiple operational modes used for generating a scheduling scheme are pre-configured. The multiple operational modes include a standard operational mode including all operational dimensions and at least one degraded operational mode including some of the operational dimensions.

Each operational dimension can be realized by a separate operation module.

Operational dimensions in each operational mode are sorted in a certain order. An output of the operational dimension sorted at the previous position is used as an input of the current operational dimension, an output of the current operational dimension is used as an input of the operational dimension sorted at the next position, and an initial scheduling scheme is used as an input of the operational dimension sorted at the first position. The data format of the input scheduling scheme of each operational dimension is consistent with the data format of the output scheduling scheme.

The operational dimensions involved in this embodiment of the present invention include, but not limited to, the following:

IP positioning operation, availability operation, quality-of-service operation and cost operation.

Step 102: State verification is performed on each operational dimension involved in the generation of a scheduling scheme.

In this step, regardless of operational dimensions forming the currently used operational mode, it is necessary to perform state verification on the currently used scheduling scheme operational mode to determine whether the state of each operational dimension is abnormal, so as to timely discover abnormal operational dimensions.

In this embodiment of the present invention, the verification involved includes the

following two aspects.

1. Verification of the operational logic: it is verified whether a scheduling scheme output after the operation of each operational dimension is abnormal.

Specifically, by using the initial scheduling scheme as the input of the operational dimension sorted at the first position and according to the sorting of operational dimensions in the currently used operational mode, the input scheduling scheme is sequentially operated to obtain an output scheduling scheme.

The output scheduling scheme is compared with the input scheduling scheme of the same operational dimension.

When the rate of change of the output scheduling scheme relative to the input scheduling scheme of the same operational dimension exceeds a preset abnormality threshold, it is determined that the operational dimension is abnormal.

2. Verification of the basic data: the timeliness of basic data of each operational dimension is verified, and it is determined that the corresponding operational dimension is abnormal when the timeliness of the basic data exceeds a corresponding failure threshold.

By taking the example of the operational dimensions in the step 101 as an example, the basic data involved in each operational dimensional is derived from the following:

the basic data corresponding to the IP positioning operation is an IP library, the basic data is derived from operation and maintenance configuration; the basic data of the availability operation is monitored data, the basic data is acquired from a database of a monitoring system; the basic data of the quality-of-service operation is quality-of-service data, the basic data is acquired from a big data platform; and, the basic data of the cost operation is acquired by a configuration management system and a big data system.

No matter whether a standard operational mode or a degraded operational mode runs currently or whether an operational mode including all operational dimensions or an operational mode including some of the operational dimensions runs currently, it is possible to perform state verification on the currently used operational mode by this step, to determine whether the currently used operational mode is normal.

After it is determined that an operational dimension is abnormal, the input scheduling scheme of the operational dimension is directly transparently transmitted to an operational

dimension sorted at a position next to the operational dimension, as an input scheduling scheme of the operational dimension at the next position.

Step 103: When one or more operational dimensions are abnormal, the abnormal operational dimension is removed to generate a new scheduling scheme.

In this step, the abnormal operational dimension can be directly removed from the standard operational mode to obtain a new operational mode, in which the sorting relationship is still reserved.

In a case where multiple different operational modes are pre-configured, it is also possible to select, from the multiple operational modes, a degraded operational mode not including the abnormal operational dimension as an operational mode for further use in the calculation of the scheduling scheme.

Further, the multiple operational modes may have different weigh values, and a degraded operational mode with a higher weight value is preferentially selected when a degraded operational mode not including the abnormal operational dimension is selected from the multiple operational modes.

For example:

standard operational mode:

IP positioning operation → availability operation → quality-of-service operation → cost operation, with a weight value of 100;

degraded operational mode 1: IP positioning operation → availability operation → quality-of-service operation, with a weight value of 90;

degraded operational mode 2: IP positioning operation → availability operation, with a weight value of 80; and

degraded operational mode 3: IP positioning operation, with a weight value of 70.

In the above example, the operation dimension "IP positioning operation" is a necessary operational dimension, i.e., the most basic operational dimension. The specific necessary operational dimension can be configured according to the system requirements, and can include multiple operational dimensions. An operational mode only including the set of necessary operational dimensions is the last guarantee for the continuous generation of the scheduling scheme.

For the detected abnormal operational dimension, it is possible to record the abnormal operational dimension or send an alarm message. Preferably, when a necessary operational dimension is abnormal, it is necessary to give a higher-level alarm.

Embodiment 2 of the present invention will be described below with reference to the accompanying drawings.

Embodiment 1 of the present invention provides a scheduling scheme configuration method, which can perform state verification on the currently used operational mode, and remove the abnormal operational dimension when an operational dimension is abnormal, so as to ensure the normal generation of the scheduling scheme. In a case where the abnormal operational dimension is removed and a scheduling scheme is continuously generated, expect that the verification is continuously performed on the currently used operational mode including some of the operational dimensions, in order to detect the recovery of the abnormal operational dimension as soon as possible and use a standard operational mode with the best performance as early as possible, this embodiment of the present invention provides another scheduling scheme configuration method, which performs continuous verification on the availability of the standard operational mode and is performed in parallel with the technical solutions provided in Embodiment 1 of the present invention. The specific flow is shown in Fig. 2 and includes the following steps.

Step 201: State verification is performed on each operational dimension in the standard operational mode.

In this step, when the currently used operational mode is a degraded operational mode or an operational mode including some of the operational dimensions, the state verification of the recovery of the standard operational mode can be started.

The verification process involved in this embodiment of the present invention may be triggered by an external instruction or may be performed periodically.

Step 202: The standard operational mode is switched back when each operational dimension in the standard operational mode is normal.

In this step, when all the operational dimensions are normal, it is determined that the standard operational mode is available, and the standard operational mode is switched back, to continuously provide a mode of generating a scheduling scheme with the best performance.

Embodiment 3 of the present invention will be described below with reference to the accompanying drawings.

This embodiment of the present invention provides a scheduling scheme configuration apparatus. The structure of the apparatus is shown in Fig. 3, including:

an abnormality detection module 301 configured to perform state verification on each operational dimension involved in the generation of a scheduling scheme; and

a scheme configuration module 302 configured to, when one or more operational dimensions are abnormal, remove the abnormal operational dimension to generate a new scheduling scheme.

Preferably, the apparatus further includes:

an operational mode management module 303 configured to configure multiple operational modes, operational dimensions included in each operational mode being different, the multiple operational modes including a standard operational mode including all operational dimensions and at least one degraded operational mode including some of the operational dimensions.

Preferably, the structure of the scheme configuration module 302 is shown in Fig. 4, including:

a first configuration unit 401 configured to remove, from the standard operational mode, the abnormal operational dimension to obtain a new operational mode; and

a second configuration unit 402 configured to select, from the multiple operational modes, a degraded operational mode not including the abnormal operational dimension as an operational mode for further use in the calculation of a scheduling scheme.

Preferably, the multiple operational modes have different weigh values, and the second configuration unit 402 is specifically configured to preferentially select a degraded operational mode with a higher weight value when a degraded operational mode not including the abnormal operational dimension is selected from the multiple operational modes.

Preferably, operational dimensions in each operational mode are sorted in a certain order; an output of the operational dimension sorted at the previous position is used as an input of the current operational dimension, an output of the current operational dimension is used as an input of the operational dimension sorted at the next position, and an initial scheduling scheme is used as an input of the operational dimension sorted at the first position; the data format of the input

scheduling scheme of each operational dimension is consistent with the data format of the output scheduling scheme; and, the structure of the abnormality detection module 301 is shown in Fig. 5, including:

- a logic verification unit 501 configured to verify whether a scheduling scheme output after the operation of each operational dimension is abnormal; and

- a data verification unit 502 configured to verify the timeliness of basic data of each operational dimension, and determine the corresponding operational dimension is abnormal when the timeliness of the basic data exceeds a corresponding failure threshold.

Preferably, the structure of the logic verification unit 501 is shown in Fig. 6, including:

- an operation subunit 601 configured to, by using the initial scheduling scheme as the input of the operational dimension sorted at the first position and according to the sorting of operational dimensions in the currently used operational mode, sequentially operate the input scheduling scheme to obtain an output scheduling scheme;

- a comparison subunit 602 configured to compare the output scheduling scheme with the input scheduling scheme of the same operational dimension; and

- a logic abnormality detection subunit 603 configured to determine that the operational dimension is abnormal, when the rate of change of the output scheduling scheme relative to the input scheduling scheme of the same operational dimension exceeds a preset abnormality threshold.

Preferably, the operation subunit 601 is further configured to, after it is determined that an operational dimension is abnormal, directly transparently transmit the input scheduling scheme of the operational dimension to an operational dimension sorted at a position next to the operational dimension, as an input scheduling scheme of the operational dimension at the next position.

Preferably, the abnormality detection module 301 further includes a standard mode detection unit 503, and the scheme configuration module 302 further includes a third configuration unit 403;

- the standard mode detection unit 503 is configured to perform state verification on each operational dimension in the standard operational mode when the currently used operational mode is a degraded operational mode; and

the third configuration unit 403 is configured to switch back to the standard operational mode when each operational dimension in the standard operational mode is normal.

Embodiment 4 of the present invention will be described below with reference to the accompanying drawings.

This embodiment of the present invention provides a scheduling scheme configuration method. During the scheduling system coverage scheme operation, it is determined whether the basic data and operational logic of each operation module (which corresponds to an operational dimension and is a specific implementation of the function of the operational dimension) are abnormal, and the operational mode is modified as a type not including the abnormal operation module for scheduling operation if the basic data and operational logic are abnormal, so that the purpose of automatic abnormality discovery and automatic fault isolation is achieved.

The service process is as follows.

1. During the scheduling system coverage scheme operation, it is determined whether the basic data and operational logic of each operation module are abnormal

1) According to the sequential order of operation modules specified by a default operation mode, tasks of the operation modules are sequentially executed. The method to process the operation modules is to acquire an original coverage scheme and an original network area-service node mapping table and calculate a new coverage scheme and a new network area-service node mapping table by using the basic data and operational logic of the operation modules.

Operational mode: each operational mode corresponds to an ordered list of operation modules, and indicates a desired sequential order in which operation modules are executed. Multiple operational modes can be configured to form an operational mode list, and a different weight is set for each operational mode. The default operational mode is a standard operational mode.

Example of the operational mode list:

|                                             |                                          |                                     |                                        |                             |                         |
|---------------------------------------------|------------------------------------------|-------------------------------------|----------------------------------------|-----------------------------|-------------------------|
| Mode 1<br>(standard<br>operational<br>mode) | IP<br>positioning<br>operation<br>module | Availability<br>operation<br>module | Quality-of-service<br>operation module | Cost<br>operation<br>module | Weight<br>value:<br>100 |
|---------------------------------------------|------------------------------------------|-------------------------------------|----------------------------------------|-----------------------------|-------------------------|

|                                             |                                          |                                     |                                        |   |                     |
|---------------------------------------------|------------------------------------------|-------------------------------------|----------------------------------------|---|---------------------|
| Mode 2<br>(degraded<br>operational<br>mode) | IP<br>positioning<br>operation<br>module | Availability<br>operation<br>module | Quality-of-service<br>operation module | - | Weight<br>value: 90 |
| Mode 3<br>(degraded<br>operational<br>mode) | IP<br>positioning<br>operation<br>module | Availability<br>operation<br>module | -                                      | - | Weight<br>value: 80 |
| Mode 4<br>(degraded<br>operational<br>mode) | IP<br>positioning<br>operation<br>module | -                                   | -                                      | - | Weight<br>value: 70 |

A. The selection of each mode in the operational mode list follows the mutual exclusion principle, that is, when all the operational modules that are not in a certain operational mode are failed, the operation of the operation modules in this operational mode will not be affected. Consequently, the operation modules of each mode are prevented from affecting each other during a fault, and the operation modules is decoupled.

B. The method for controlling operation modules is to use each operation module as a standard micro-service. The input and output files of each operation module are the same in type and format and the calling interfaces of the operation modules are the same, so different operation modules can be freely combined for calculating the scheduling coverage scheme. The output of the operation module at the previous position can be used as the input of the operation module at the next position.

2) The method for determining whether the new coverage scheme and the new network area-service node mapping table are abnormal is as follows.

A. Determination of the operational logic: the rate of change of the new coverage scheme and the new network area-service node mapping table relative to the original versions is determined, and it is considered that the new coverage scheme and the new network area-service node mapping table are abnormal if the rate of change exceeds a specified threshold.

B. Determination of the basic data: the timeliness of the basic data of each operation

module is determined, and it is considered that the basic data is abnormal if the timeliness exceeds a specified threshold.

3) If it is abnormal, the attribute of the operation module is identified as abnormal, and the new coverage scheme and the new network area-service node mapping table are used as an original coverage scheme and an original network area-service node mapping table of the next operation module in the sequential order of operation modules specified by the default operational mode, and the above processing and determination are continuously performed on the operation modules till to the last operation module. The new coverage scheme is used as a coverage scheme to be issued. That is, the data obtained by correcting the abnormal operation module will not be used by the operation module at the next position, and the input of the abnormal operation module is directly transparently transmitted to the operation module at the next position.

## 2. Confirmation and modification of the operational mode:

1) The attribute of each operation module is acquired.

2) If the attributes of all operation modules are normal, the current operational mode is maintained, and the coverage scheme to be issued is transmitted to a scheduling module for configuration file updating, so as to adjust the scheduling strategy.

3) If the attributes of one or more operation modules are abnormal, an operational mode not including any operation module with the abnormal attribute and having the highest weight is used as the currently-used degraded operational mode. In the normal case, the degraded operational mode is null. When the degraded operational mode is not null, the operation of the coverage scheme is executed preferentially according to the degraded operational mode.

3. The specified operation module is used according to the degraded operational mode to perform scheduling system coverage scheme operation, and it is evaluated whether the operation module specified by the standard mode returns to normal.

1) Scheduling system coverage scheme operation is performed according to the new operational mode, and the coverage scheme is issued to the scheduling module for configuration file updating so as to adjust the scheduling strategy.

2) The standard module is performed synchronously to perform scheduling system coverage scheme operation. If the attributes of all the operation modules are normal, the degraded

operational mode is cleared, and the standard mode operation is recovered.

An embodiment of the present invention further provides a computer readable storage medium storing computer programs that, when executed by a processor, implement the steps of the method described above.

An embodiment of the present invention further provides a computer device, including a memory, a processor and computer programs that are stored on the memory and runnable on the processor, the processor implementing the steps of the method described above when executing the programs.

An embodiment of the present invention provides a scheduling scheme configuration apparatus, which can be combined with the scheduling scheme configuration method provided by the embodiments of the present invention to divide the basic specific operation links of an operational mode into multiple operational dimensions, perform state verification on operational dimensions involved in the generation of a scheduling scheme, and remove the abnormal operational dimension to generate a new scheduling scheme when one or more operational dimensions are abnormal. The discovery and automatic correction of an abnormal operational mode are realized, the normal generation of a scheduling scheme is ensured, and reliable network services are thus ensured. In accordance with the difference comparison of the coverage scheme and the network area-service node mapping table before and after operation and the timeliness of basic data, the automatic detection of the basic data and the operational logic of the scheduling operation module is realized; a scheme of controlling the scheduling operation module based on the operational mode is provided; and, a hierarchical scheduling operation system is realized, and the fast isolation of a fault is realized.

The contents described above can be implemented independently or jointly in various ways, and these variants shall fall into the protection scope of the embodiments of the present invention.

Finally, it is to be noted that the foregoing embodiments are merely used for describing the technical solutions of the embodiments of the present invention, rather than limiting the technical solutions of the embodiments of the present invention. Although the present invention has been described in detail by the foregoing embodiments, it should be understood that a person of ordinary skill in the art can make modifications to the technical solutions recorded in the

foregoing embodiments or equivalent replacements to some of the technical features, and these modifications or replacements shall not make the essence of the corresponding technical solutions depart from the spirit and scope of the technical solutions in the embodiments of the present invention.

#### INDUSTRIAL APPLICABILITY

The embodiments of the present invention provide a scheduling scheme configuration apparatus, which realizes the discovery and automatic correction of an abnormal operational mode, ensures the normal generation of a scheduling scheme and thus ensures reliable network services. Moreover, in accordance with the difference comparison of the coverage scheme and the network area-service node mapping table before and after operation and the timeliness of basic data, the automatic detection of the basic data and operational logic of the scheduling operation module is realized; a scheme of controlling the scheduling operation module based on the operational mode is provided; and, a hierarchical scheduling operation system is realized, and the fast isolation of a fault is realized.

## CLAIMS

1. A scheduling scheme configuration method, comprising steps of:

performing state verification on each operational dimension involved in the generation of a scheduling scheme; and

when one or more operational dimensions are abnormal, removing the abnormal operational dimension to generate a new scheduling scheme;

further comprising a step of:

configuring multiple operational modes, operational dimensions included in each operational mode being different, the multiple operational modes comprising a standard operational mode including all operational dimensions and at least one degraded operational mode including some of the operational dimensions;

wherein operational dimensions in each operational mode are sorted in a certain order; an output of the operational dimension sorted at the previous position is used as an input of the current operational dimension, an output of the current operational dimension is used as an input of the operational dimension sorted at the next position, and an initial scheduling scheme is used as an input of the operational dimension sorted at the first position; and, the data format of the input scheduling scheme of each operational dimension is consistent with the data format of the output scheduling scheme.

2. The scheduling scheme configuration method according to claim 1, wherein the step of, when one or more operational dimensions are abnormal, removing the abnormal operational dimension to generate a new scheduling scheme comprises:

removing, from the standard operational mode, the abnormal operational dimension to obtain a new operational mode; or,

selecting, from the multiple operational modes, a degraded operational mode not including the abnormal operational dimension as an operational mode for further use in the calculation of a scheduling scheme.

3. The scheduling scheme configuration method according to claim 2, wherein the multiple operational modes have different weigh values, and a degraded operational mode with a higher weight value is preferentially selected when a degraded operational mode not including the abnormal operational dimension is selected from the multiple operational modes.

4. The scheduling scheme configuration method according to claim 1, wherein the step of performing state verification on each operational dimension involved in the generation of a scheduling scheme comprises:

verifying whether the scheduling scheme output after the operation of each operational dimension is abnormal; and

verifying the timeliness of basic data of each operational dimension, and determining the corresponding operational dimension is abnormal when the timeliness of the basic data exceeds a corresponding failure threshold.

5. The scheduling scheme configuration method according to claim 4, wherein the step of verifying whether the scheduling scheme output after the operation of each operational dimension is abnormal comprises:

by using the initial scheduling scheme as the input of the operational dimension sorted at the first position and according to the sorting of operational dimensions in the currently used operational mode, sequentially operating the input scheduling scheme to obtain an output scheduling scheme;

comparing the output scheduling scheme with the input scheduling scheme of the same operational dimension; and

when the rate of change of the output scheduling scheme relative to the input scheduling scheme of the same operational dimension exceeds a preset abnormality threshold, determining that the operational dimension is abnormal.

6. The scheduling scheme configuration method according to claim 5, wherein, after it is determined that an operational dimension is abnormal, the input scheduling scheme of the operational dimension is directly transparently transmitted to an operational dimension sorted at a position next to the operational dimension, as an input scheduling scheme of the operational dimension at the next position.

7. The scheduling scheme configuration method according to claim 5, wherein, when the currently used operational mode is a degraded operational mode, the method further comprises steps of:

performing state verification on each operational dimension in the standard operational mode; and

switching back to the standard operational mode when each operational dimension in the standard operational mode is normal.

8. A scheduling scheme configuration apparatus, comprising:

an abnormality detection module configured to perform state verification on each operational dimension involved in the generation of a scheduling scheme; and

a scheme configuration module configured to, when one or more operational dimensions are abnormal, remove the abnormal operational dimension to generate a new scheduling scheme;

the apparatus further comprising:

an operational mode management module configured to configure multiple operational modes, operational dimensions included in each operational mode being different, the multiple operational modes comprising a standard operational mode including all operational dimensions and at least one degraded operational mode including some of the operational dimensions;

wherein operational dimensions in each operational mode are sorted in a certain order; an output of the operational dimension sorted at the previous position is used as an input of the current operational dimension, an output of the current operational dimension is used as an input of the operational dimension sorted at the next position, and an initial scheduling scheme is used as an input of the operational dimension sorted at the first position; the data format of the input scheduling scheme of each operational dimension is consistent with the data format of the output scheduling scheme.

9. The scheduling scheme configuration apparatus according to claim 8, wherein the scheme configuration module comprises:

a first configuration unit configured to remove, from the standard operational mode, the abnormal operational dimension to obtain a new operational mode; and

a second configuration unit configured to select, from the multiple operational modes, a degraded operational mode not including the abnormal operational dimension as an operational mode for further use in the calculation of a scheduling scheme.

10. The scheduling scheme configuration apparatus according to claim 9, wherein the multiple operational modes have different weight values, and

the second configuration unit is specifically configured to preferentially select a degraded operational mode with a higher weight value when a degraded operational mode not including

the abnormal operational dimension is selected from the multiple operational modes.

11. The scheduling scheme configuration apparatus according to claim 8, the abnormality detection module comprises:

a logic verification unit configured to verify whether a scheduling scheme output after the operation of each operational dimension is abnormal; and

a data verification unit configured to verify the timeliness of basic data of each operational dimension, and determine the corresponding operational dimension is abnormal when the timeliness of the basic data exceeds a corresponding failure threshold.

12. The scheduling scheme configuration apparatus according to claim 11, wherein the logic verification unit comprises:

an operation subunit configured to, by using the initial scheduling scheme as the input of the operational dimension sorted at the first position and according to the sorting of operational dimensions in the currently used operational mode, sequentially operate the input scheduling scheme to obtain an output scheduling scheme;

a comparison subunit configured to compare the output scheduling scheme with the input scheduling scheme of the same operational dimension; and

a logic abnormality detection subunit configured to determine that the operational dimension is abnormal, when the rate of change of the output scheduling scheme relative to the input scheduling scheme of the same operational dimension exceeds a preset abnormality threshold.

13. The scheduling scheme configuration apparatus according to claim 12, wherein,

the operation subunit is further configured to, after it is determined that an operational dimension is abnormal, directly transparently transmit the input scheduling scheme of the operational dimension to an operational dimension sorted at a position next to the operational dimension, as an input scheduling scheme of the operational dimension at the next position.

14. The scheduling scheme configuration apparatus according to claim 13, wherein the abnormality detection module further comprises a standard mode detection unit, and the scheme configuration module further comprises a third configuration unit;

the standard mode detection unit is configured to perform state verification on each operational dimension in the standard operational mode when the currently used operational

mode is a degraded operational mode; and

the third configuration unit is configured to switch back to the standard operational mode when each operational dimension in the standard operational mode is normal.

15. A computer readable storage medium storing computer programs that, when executed by a processor, implement the steps of the method according to any one of claims 1 to 7.

16. A computer device, comprising a memory, a processor and computer programs that are stored on the memory and runnable on the processor, the processor implementing the steps of the method according to any one of claims 1 to 7 when executing the programs.