estimate and predict the activity, energy consumption and/or resource flow (for instance heat, power and/or ventilation) of the critical devices.

Accordingly, it is an object of the present invention to provide a system for monitoring resource flow(s) at a number of devices, which system is less expensive and complicated than the prior systems that apply traditional monitoring technologies.

It is also an object of the present invention to provide a system that is capable of estimating and predicting the activity, energy consumption and/or resource flow (e.g. heat, power and/or ventilation) of a number of predefined devices.

Summary of the invention

In one aspect, there is provided a system for monitoring resource flow(s) at a number of devices, which system comprises a receiving unit configured to receive data from

A. a number of sensors configured to detect the flow rate and/or the change in the flow rate at device level, and

B. a high precision meter configured to measure the overall flow for at least a part of the devices by a predefined high accuracy,

characterised in that the system comprises a calculation module configured to receive information from the sensors and the meter, where the calculation module comprises a mathematical statistic model configured to estimate and/or predict the latent stochastic process, (i.e. flow of resources and/or performance (e.g. activity), of the devices by using data from the sensors and the meter); where the data from the sensors and the meter at time t are given as a vector (Y_t), where the latent stochastic process (flow of resources and/or performance such as percent ventilation efficiency, percent overconsumption of resources, resource flow or device health status) at time t is a vector (θ_t), where the mathematical statistic model uses

a noise vector (ε_t) of the data from the sensors and the meter at time t and eventually a noise vector (ϑ_t) of the latent stochastic process at time t, where the statistical distribution of the noise vectors (ε_t, ϑ_t) are estimated on the basis of the data from the sensor and the meter.

In another aspect, there is provided a method for monitoring resource flow(s) at a number of devices by using a receiving unit which receives data from a number of sensors configured to detect the flow rate and/or the change in the flow rate at device level, and a high precision meter configured to measure the flow of at least a selection of the devices by a predefined high accuracy, characterised in that the method comprises the step of estimating and/or predicting loss and/or flow of resource(s) of the devices by using a calculation module configured to receive information from the sensors and the meter, where the estimating and/or predicting of resource flows is carried out in a calculation module that comprises a mathematical model by using data from the sensors and the meter, where the mathematical model is configured to estimate the latent stochastic process using a mathematical statistic model, where the mathematical statistic model combines data from the sensors and the meter to estimate the latent stochastic process, where the data from the sensor and the meter at time t are given as a vector (Y_t), where the latent stochastic process (flow of resources and/or performance such as percent ventilation efficiency, percent overconsumption of resources, resource flow or device health status) at time t is a vector (θ_t), where the mathematical statistic model uses a noise vector (ε_t) of the data from the sensors and the meter at time t and eventually a noise vector (ϑ_t) of the latent stochastic process at time t, where the statistical distribution of the noise vectors (ε_t, ϑ_t) are estimated on the basis of the data from the sensor and the meter.

The objects of the present invention can be achieved by a system as defined in claim 1 and by a method as defined in claim 12. Preferred

Claims

1. A system for monitoring resource flow(s) at a number of devices, which system comprises a receiving unit configured to receive data from

A. a number of sensors configured to detect the flow rate and/or the change in the flow rate at device level, and

B. a high precision meter configured to measure the overall flow for at least a part of the devices by a predefined high accuracy,

characterised in that the system comprises a calculation module configured to receive information from the sensors and the meter, where the calculation module comprises a mathematical statistic model configured to estimate and/or predict the latent stochastic process, (i.e. flow of resources and/or performance (e.g. activity), of the devices by using data from the sensors and the meter); where the data from the sensors and the meter at time t are given as a vector (Y_t), where the latent stochastic process (flow of resources and/or performance such as percent ventilation efficiency, percent overconsumption of resources, resource flow or device health status) at time t is a vector (θ_t), where the mathematical statistic model uses a noise vector (ε_t) of the data from the sensors and the meter at time t and eventually a noise vector (ϑ_t) of the latent stochastic process at time t, where the statistical distribution of the noise vectors (ε_t, ϑ_t) are estimated on the basis of the data from the sensor and the meter.

2. A system according to claim 1, characterised in that the data from the sensor and the meter at time t are given as a vector, Y_t given by:

- $$\boldsymbol{Y_t = f_t(\theta_t) + \varepsilon_t} ,$$

where the latent stochastic process (flow of resources and/or performance such as percent ventilation efficiency, percent overconsumption of resources, resource flow or device health status) at time t is a vector θ_t which eventually can be modelled by the underlying process:

- $$\boldsymbol{\theta_t = g_t(\theta_{t-1}) + \vartheta_t} ,$$

where f_t and g_t are mathematical functions.

3. A system according to one of the preceding claims, characterised in that the high precision meter is configured to measure the total power flow for a group of electrical devices or to measure the total water flow or to measure energy consumption.

4. A system according to one of the preceding claims, characterised in that the system comprises a user interface, preferably a remote user interface and that the user interface provides access to the estimated and/or predicted resource flow(s) of at least a selection of the devices.

5. A system according to one of the preceding claims, characterised in that the calculation module is one or more routers.

6. A system according to one of the preceding claims, characterised in that one or more of the sensors comprises an energy harvester.

7. A system according to claim 6, characterised in that the harvested energy is used to detect resource flow or change resource flow rate of the devices.

8. A system according to one of the preceding claims, characterised in that the calculation module and the mathematical model are integrated in an apparatus of the system.

9. A system according to one of the preceding claims, characterised in that the calculation module is a cloud service comprising a mathematical model and a data storage.

10. A system according to one of the preceding claims, characterised in

that the system comprises a control unit configured to change the activity of one or more of the devices or another apparatuses, e.g. a valve of a main pipe.

11. A system according to one of the preceding claims, characterised in that the calculation module is configured to estimate the actual and/or future activity of at least a selection of the devices.

12. A method for monitoring resource flow(s) at a number of devices by using a receiving unit which receives data from a number of sensors configured to detect the flow rate and/or the change in the flow rate at device level, and a high precision meter configured to measure the flow of at least a selection of the devices by a predefined high accuracy, characterised in that the method comprises the step of estimating and/or predicting loss and/or flow of resource(s) of the devices by using a calculation module configured to receive information from the sensors and the meter, where the estimating and/or predicting of resource flows is carried out in a calculation module that comprises a mathematical model by using data from the sensors and the meter, where the mathematical model is configured to estimate the latent stochastic process using a mathematical statistic model, where the mathematical statistic model combines data from the sensors and the meter to estimate the latent stochastic process, where the data from the sensor and the meter at time t are given as a vector (Y_t), where the latent stochastic process (flow of resources and/or performance such as percent ventilation efficiency, percent overconsumption of resources, resource flow or device health status) at time t is a vector (θ_t), where the mathematical statistic model uses a noise vector (ε_t) of the data from the sensors and the meter at time t and eventually a noise vector (ϑ_t) of the latent stochastic process at time t, where the statistical distribution of the noise vectors (ε_t, ϑ_t) are estimated on the basis of the data from the sensor and the meter.

13. A method according to claim 12, characterised in that the data from the sensor and the meter at time t are given as a vector, Y_t given by:

- $$Y_t = f_t(\theta_t) + \varepsilon_t ,$$

where the latent stochastic process (flow of resources and/or performance such as percent ventilation efficiency, percent overconsumption of resources, resource flow or device health status) at time t is a vector θ_t which eventually can be modelled by the underlying process:

- $$\theta_t = g_t(\theta_{t-1}) + \vartheta_t ,$$

where f_t and g_t are mathematical functions.

14. A method according to claim 12 or 13, characterised in that the method uses a system as defined in claim 1-11 to estimate and/or predict resource flow of the devices.