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Tolubko V. B., Sc. D.; **Komarova L. O.,** Ph. D.; **Ilin O. O.,** Ph. D.
(State university of telecommunications, Kiev. +380 (44) 248 85 97. lacosta_k@ukr.net, ilin.oa@duikt.edu.ua)

AN EFFECTIVE STRUCTURE OF THE DYNAMIC MONITORING SYSTEM OF TELECOMMUNICATION NETWORK OBJECTS USING MOBILE MEASURING DEVICES IN REAL-TIME

Толубко В. Б., Комарова Л. О., Ільїн О. О. Ефективна структура системи динамічного моніторингу об'єктів телекомунікаційної мережі з використанням мобільних вимірювальних пристроїв у реальному часі. Розглядається проблема реалізації систем моніторингу параметрів об'єктів телекомунікаційної мережі зі збільшеною інформативністю про точки проведення вимірювань. Запропонована та обгрунтована ефективна структура модернізованої системи моніторингу для випадку використання в ній як стаціонарних, так і мобільних вимірювальних пристроїв, які функціонують у реальному часі. Окреслені шляхи підвищення ефективності системи за рахунок зменшення навантаження на канал зв'язку з центром обробки даних. Показані основні переваги модернізованої системи для випадків здійснення локального та глобального моніторингу, коли зміна координат вимірювальних пристроїв та виміряних параметрів незначна.

Ключові слова: телекомунікаційна мережа, моніторинг, контрольований об'єкт, вимірювальний пристрій, інформаційна система

Толубко В. Б., Комарова Л. А., Ильин О. А. Эффективная структура системы динамического мониторинга объектов телекоммуникационной сети с использованием мобильных измерительных устройств в реальном времени. Рассматривается проблема реализации систем мониторинга параметров объектов телекоммуникационной сети с увеличенной информативностью о точках проведения измерений. Предложена и обоснована эффективная структура модернизированной системы мониторинга для случая использования в ней как стационарных, так и мобильных измерительных устройств, которые функционируют в реальном времени. Очерчены пути повышения эффективности системы за счет уменьшения нагрузки на канал связи с центром обработки данных. Показаны основные преимущества модернизированной системы для случаев осуществления локального и глобального мониторинга, когда изменение координат измерительных приборов и измеренных параметров незначительны.

Ключевые слова: телекоммуникационная сеть, мониторинг, контролируемый объект, измерительное устройство, информационная система

Tolubko V. B., Komarova L. O., Ilin O. O. An effective structure of the dynamic monitoring system of telecommunication network objects using mobile measuring devices in real-time. The problem of the implementation of monitoring systems of the parameters of objects of telecommunication network with increased information about the point of measurements is considered. The effective structure for the upgraded monitoring system, in case using the stationary and mobile measuring devices in it which operate in real-time, is offered and substantiated. The ways of improving the efficiency of the system by reducing the load on the link to the data center are delineated. The main advantages of the modernized system for the cases of implementation of the local and global monitoring, when changing of the coordinates of the measurement devices and measured parameters are insignificant are shown.

Keywords: telecommunication network, monitoring, controlled object, measuring device, information system

Statement of the problem. Objectives of the research. Today in the developed countries of the world deep qualitative changes are held, which caused by rapid scientific-technological progress and the information revolution, which requires solving a number of problems which have both the organizational and the technical nature, the primary of which is the creation of an information and communication network that will provide the transfer of the accurate and complete information about the situation in real time. The systems of the dynamic monitoring of the parameters of the objects of the telecommunication networks (TCN) are widely used in modern conditions. They can collect information on a global scale, for example, even within the state. Herewith, the most widespread are systems, which use the stationary measuring devices (MD) of those parameters of the objects of the TCN for which monitoring is carried. However, such system provides monitoring only in a few fixed points, which may not be enough within the state. There may be cases when in the fixed points parameters of TCN will not exceed the permissible limits, but the situation between them can be alarming.

Therefore, topical is the problem of implementation the system of monitoring the parameters of the objects TCN with increased informativeness about points of measurements by providing the functioning not only stationary MD, but also mobile MD in the system. It is possible to use the known structures of monitoring systems using stationary MD, expanding them by adding a large number of mobile MD. However, these expanded systems will not be very effective. Therefore, the relevant question is the formation of an effective structure monitoring systems, especially radiomonitoring, which use axcept the stationary MD significant number of mobile options in real-time.

About the possibility of a practical approach to solving the problem of multi monitor show the researches of V. M. Zherdiev, S. D. Degtyariov, P. S. Rusynov, V. L. Bocharov, V. M. Smolianinov, V. M. Zolotoriov, A. V. Nazarenko, T. N. Zadorozhna (synoptic meteorology and aeroekology) and others. Analysis of the literature [1, 2] shows that the most widespread monitoring systems contain a small number of fixed MD. An example of such a system [3] is control ling the radiation background in Germany. Also considered systems [4], which contain a small number of mobile MD (usually, in specially equipped cars). But there is almost no information about the structure of the monitoring systems, which contain hundreds of thousands of mobile-MD which are working in real time.

Explored in this paper the systems of dynamic monitoring of the controlled objects of telecommunications network using mobile measuring devices in real time are significantly different from existing systems so that they consists of an extremely large amount of MD. This sharply increases the volume of the transferred information and the complexity of its further processing.

According to above, ***the purpose of the article*** is the proved choice of an effective structure of monitoring system of controlled objects of TCN using a large number of real time mobile MD.

Statement of the main material. Consider the universal scheme of the information system of control of the environmental condition, suitable both for the system as a whole and for arbitrary geophysical service, which is included in the system (Fig. 1).

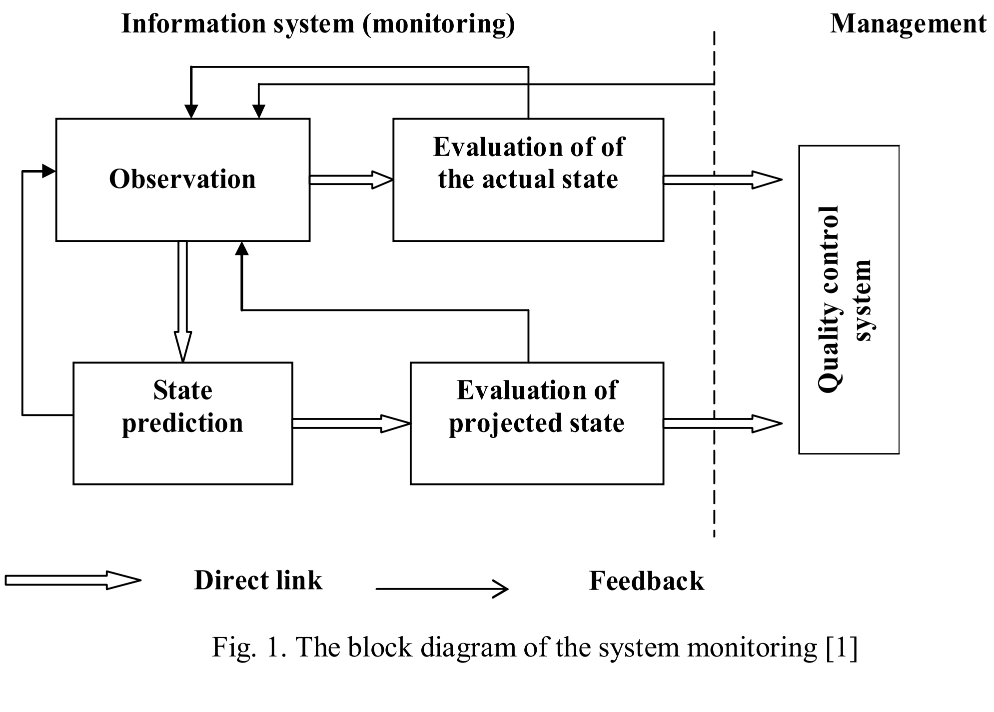

Fig. 1. The block diagram of the system monitoring [1]

The most universal approach to definition of the structure of monitoring system of anthropogenic changes of parameters of TCN is separating it on units: monitoring, forecast of the state, assessment of the projected state, assessment of the real state.

Monitoring systems using stationary MD. Fig. 2 shows the functional diagram of the system of monitoring the radiation level [3], which contains only stationary MD, in which the resulting information is placed on a dedicated website on the Internet.

The system consists of a certain number of stationary measuring devices ($MD_1 ... MD_N$), each of which MD_i contains: a sensor for measuring the probability of error $\mathbf{Am_i}$, a device (usually GPS) with resolving capacity of the data coordinates of longitude $\mathbf{Ad_i}$**,** latitude $\mathbf{As_i}$**,** height $\mathbf{Ah_i}$ its location, time measurement $\mathbf{At_i}$**.** Next the array of data through a communications channel (wired or wireless) is transmitted in the data center and displayed on a dedicated website on the Internet. However, this system provides monitoring only a few fixed points that may not be enough.

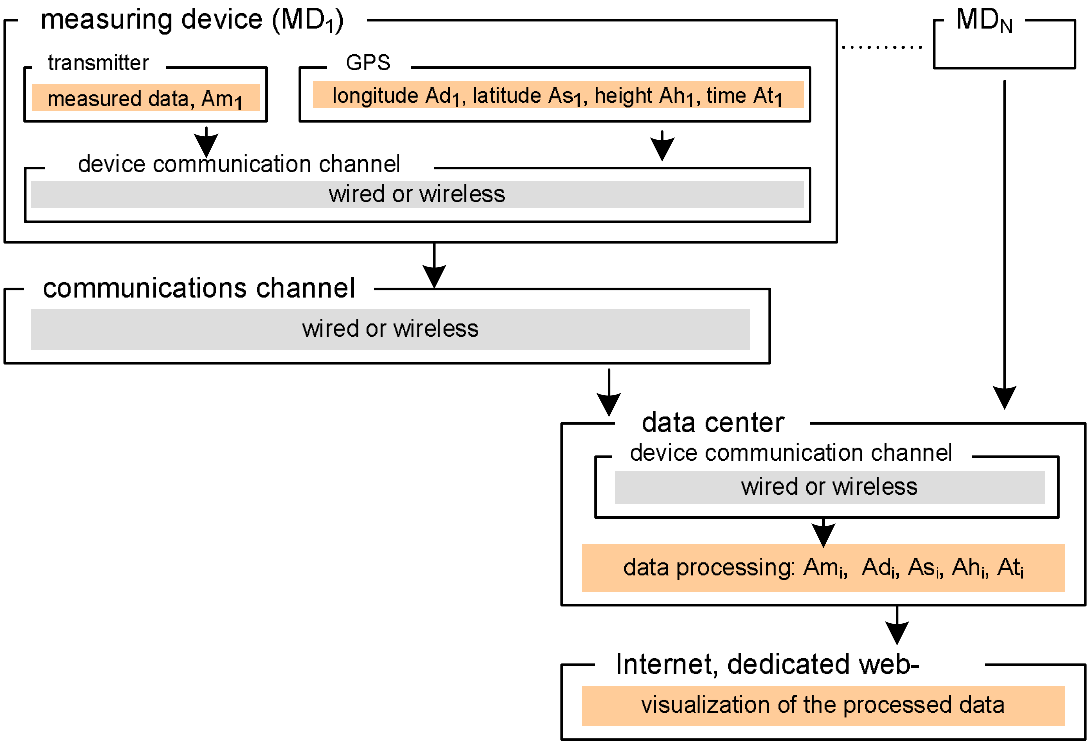

Fig. 2. The system of dynamic monitoring with using the stationary MD

So urgent is the problem of implementation of a monitoring system of parameters of controlled objects of the telecommunication network using mobile measurement devices with increased information content about the point of measurement, by ensuring the functioning in the system not only the stationary MD, but also mobile. At the same time as device communication channel (Fig. 2) a mobile phone is most appropriate to use.

The GPS device can be available at the transmitter, or in a mobile phone. In their absence it is necessary to use additional GPS device. This system is more flexible and informative, because the mobile measuring devices can be distributed to a considerable part of the population. If the functioning of the monitoring system is carried out under the auspices of the state, the MD can be distributed to many mobile subscribers (for example, drivers of city, regional and interregional buses).

As a result, you can get information about the status of the parameters of the controlled object, not only in the few fixed points, but almost on the entire territory of the state, or even neighboring countries. But when building a system with mobile MD their number increases in the tens to hundreds of times, causing a sharp increase in the workload of the communication channel and volume of information that must be processed in the data center. Therefore there is a necessity for modernization of the structure of the system in order to reduce the specified load.

The modernized system of monitoring of stationary and mobile MD. Fig. 3 shows the structure of the modernized system. In this case, the signals in the data center do not come from each MD, but only from the centers of the packet data (CPD), whose number is significantly smaller than the number of MD:

$$\mathbf{Nc << Nv} \quad (\mathbf{Nc, Nv} - \text{amount of CPD and the MD, respectively}) \qquad \mathbf{(1)}$$

It is obvious that if the condition (1) workload of the communication channel with the data center is sharply reduced. To determine the number of the CPD and their location, all the territory to be monitored is divided into separate rectangular sections with step

$$\mathbf{\Delta As = (Ad_в - Ad_н)/N_s} \quad - \quad \text{for latitude;} \qquad \mathbf{(2,a)}$$

$$\mathbf{\Delta Ad = (Ad_в - Ad_н)/N_d} \quad - \quad \text{for longitude,} \qquad \mathbf{(2,b)}$$

where $\mathbf{As_н}$, $\mathbf{As_в}$ $\mathbf{(Ad_н, Ad_в)}$ – the minimum and maximum values of latitude (longitude) within the monitored area; $\mathbf{N_s}$, $\mathbf{N_d}$ – number of sections in latitude and longitude, respectively.

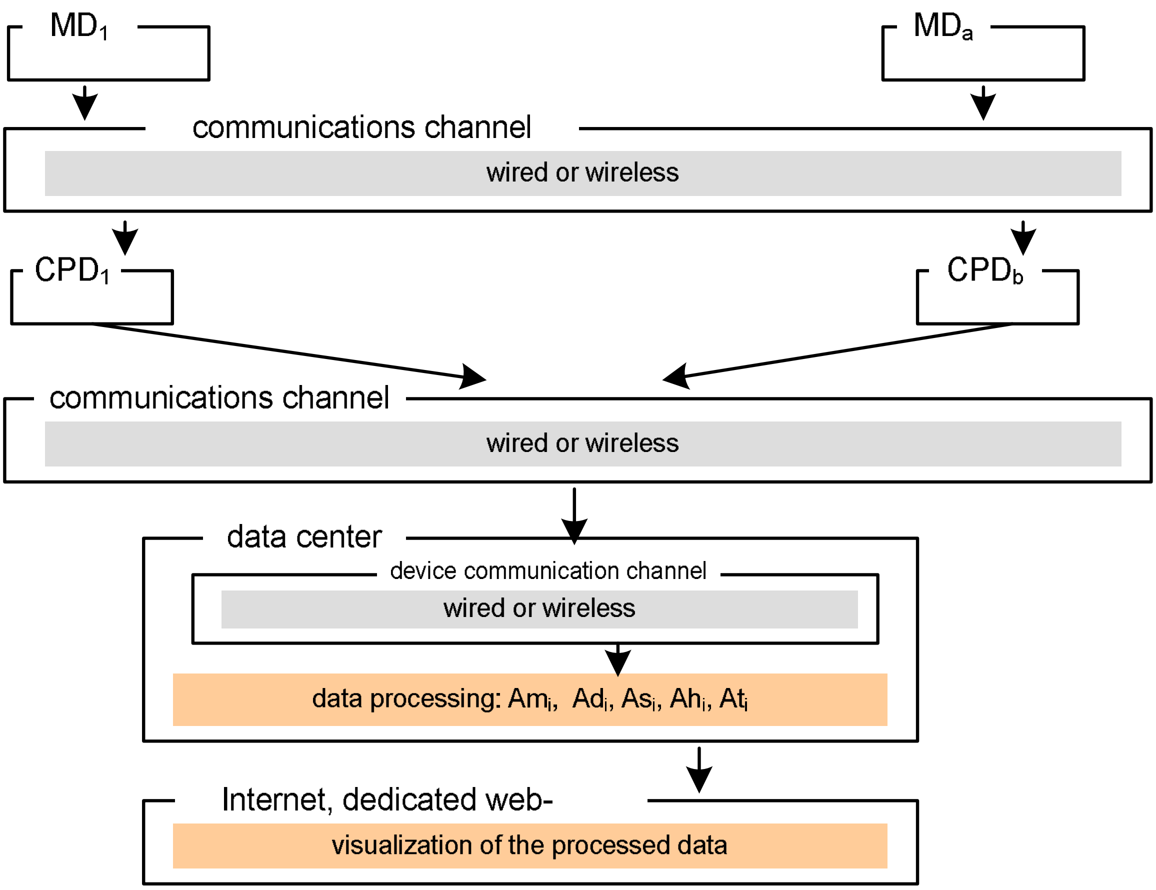

Fig. 3. The modernized system of monitoring using the stationary and mobile MD

Thus, each of the sections can be characterized set of coefficients **m** and **n**, moreover the coordinates of points for $\mathbf{As_i}$ and $\mathbf{Ad_i}$ within each section condition:

$$\mathbf{As_{н}m \leq As_i \leq As_{н}(m+1)} \text{ – for latitude;} \quad \mathbf{(3,a)}$$

$$\mathbf{Ad_{н}n \leq Ad_i \leq Ad_{н}(n+1)} \text{ – for longitude,} \quad \mathbf{(3,b)}$$

where $\mathbf{1 \leq m \leq N_s - 1}$, $\mathbf{1 \leq n \leq N_d - 1}$.

It is obviously, that the total number of individual sections is:

$$\mathbf{N_{ds} = N_d N_s}. \quad \mathbf{(4)}$$

Within each of the sections $\mathbf{N_{ds}}$ installed CPD_i.

Through the device (usually a mobile phone) outbound channel (Fig. 4) from with each of the CPD signal is fed into the data center (see Fig. 2). On the device (also, as a rule, mobile phone) input channel of the CPD (see Fig. 3) data comes only from a certain group of MD, which are located in the vicinity of this CPD. For this MD are complicated (compared with the Fig. 2) by adding them to the signal processing device (Fig. 5).

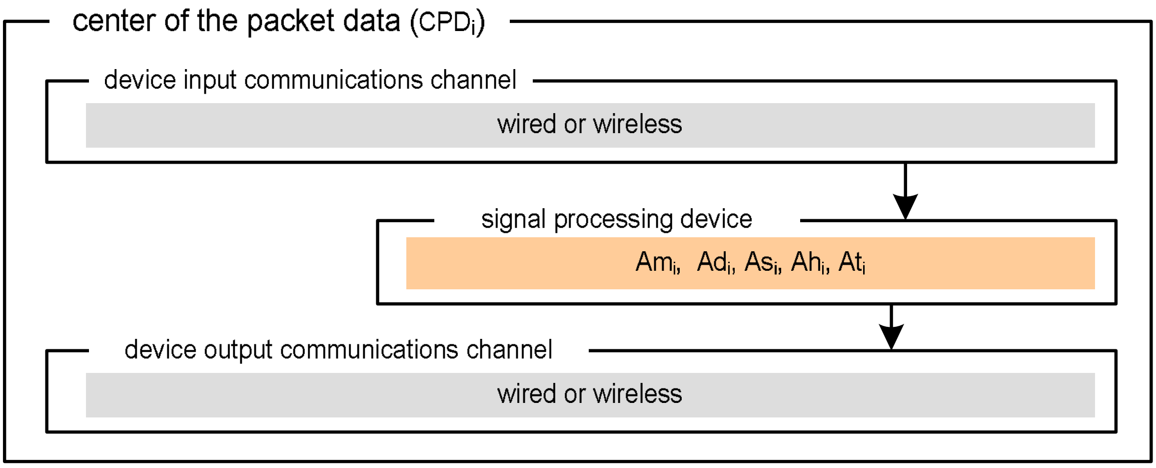

Fig. 4. The packet data center

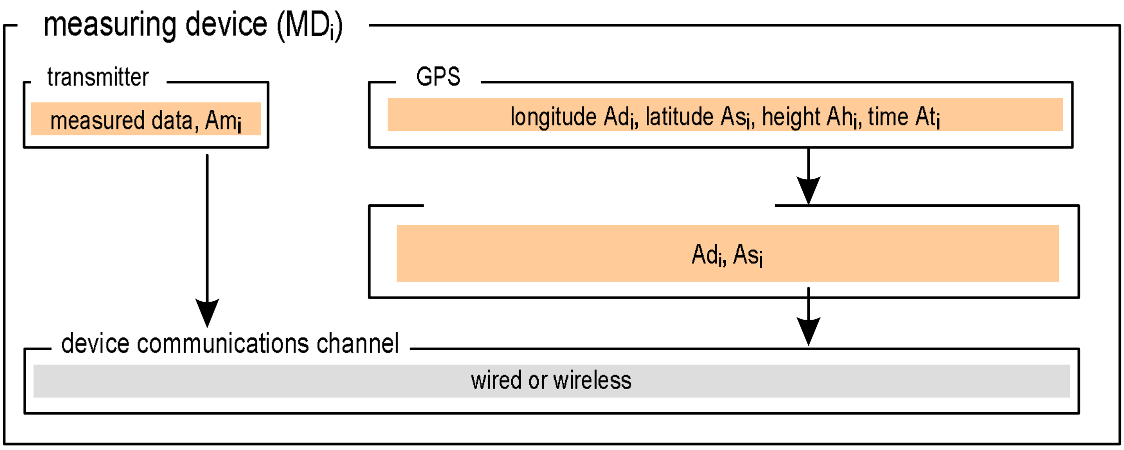

Fig. 5. Complicated MD

For coordinates of points $\mathbf{As_i}$ and $\mathbf{Ad_i}$ MD, which performing local monitoring following conditions are satisfied:

$$\mathbf{Bs_н} \le \mathbf{As_i} \le \mathbf{Bs_в} \text{ – for latitude;} \quad \textbf{(5,a)}$$

$$\mathbf{Bd_н} \le \mathbf{Ad_i} \le \mathbf{Bd_в} \text{ – for longitude,} \quad \textbf{(5,b)}$$

where $\mathbf{Bs_н}$, $\mathbf{Bs_в}$ ($\mathbf{Bd_н}$, $\mathbf{Bd_в}$) – minimum and maximum latitude (longitude) of the territory to which the local monitoring is carried out.

In the devices of signal's processing on the basis of the obtained data about the coordinates ($\mathbf{As_i}$, $\mathbf{Ad_i}$) location of MD in a particular time and dependencies (5,a), (5,b) determines the coefficients m and n, then there CPD to which you want to send signals from a particular VPI (Fig. 4) depending on its place in a given time.

3. The benefits of the upgraded system. Monitoring of the controlled objects of telecommunication network using mobile measurement devices can be carried out both global and local, for example, within the same premises in case of occurrence in it of an emergency.

If adopted from the CPD data from various MD following conditions are satisfied (5,a) and (5,b), in the data center (Fig. 4) is enough to send only one value with the highest value measured data $\mathbf{Am_i}$. The fact that users in the selected site in the Internet not interested in how the situation changes within the premises – they are only interested in the maximum value of measured parameter on the territory of its location. The change of the situation inside the premises is useful to the customer of the given local monitoring. Such information for the customer is formed in the CPD, which received signals of local monitoring. Thus, in the implementation of local monitoring of controlled objects of telecommunication network using mobile measurement devices is significantly reduced (Fig. 4) workload of the communication channels and data center compared to using the structure (Fig. 3).

Another advantage of the upgraded system available in the possible cases when the mobile MD are some time to rest (for example, at the bus stops or non-business hours). In this case, the CPD rather than sending the data about the coordinates MD may transfer only a short conditional “label” that the coordinates of the recipient has not changed. In the data center based on the approved label for this MD on the website only change the values of the measured data $\mathbf{Am_i}$.

Note if the mobile MD even is at rest, it still cannot be turned off, because it performs its function carries out measurements at this point, where may at any time be an emergency.

Other advantages of the modernized system are obviously based on our review of the main characteristics of the system (Table 1).

The main characteristics of the systems of monitoring **Table 1**

Name	Value
Accuracy of definition of coordinates (latitude and longitude) at the point of measurement	$\mathbf{\Delta As}$ – latitude, $\mathbf{\Delta Ad}$ – longitude
The accuracy of determination of a parameter for which the monitoring is carrying out	$\mathbf{\Delta Am}$

There may be situations when a mobile user changes their position within the less $\mathbf{\Delta As}$ and $\mathbf{\Delta Ad}$ (for example, bus during repair in garage). In the CPD detected signals from these MD_s, and instead of passing their coordinates are transmitted only “label”. In the data center based on the approved label for this MD on the website only the values of the measured data $\mathbf{Am_i}$. is changing (similarly as for the OP, that was at rest) .

There may be situations, where mobile MD that was in a state of rest or change its coordinates within smaller Δ**As** and Δ**Ad,** changing the value of parameter $\mathbf{Am_i}$ does not exceed the values Δ**Am.** Then it is also enough to send the appropriate label on the basis of which on the website change only the time of receipt of the information from the subscriber.

The benefits of the upgraded system also include the fact that the specific CPD, has received an information from many MD may not be sent to the processing center data (Fig. 4) data on the time of receipt of information from each MD, and only about one group time, that concerns all subscribers.

The above described only the basic (not completed) benefits of the proposed upgraded monitoring system (Fig. 4).

The conclusions. The proposed effective structure of the upgraded system of ecological monitoring for a case of use it both stationary and mobile MD. Improving of the efficiency of the system is ensured by reducing the load on the communication channel with the data center and amount of information to be processed, in the presence of a significant number of MD.

The main advantages of the upgraded system for cases: implementation of local monitoring, the implementation of the global monitoring when a change of coordinates MD and measured parameters insignificant are shown.

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