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## **SOFTWARE DEVELOPMENT FOR DISTRIBUTED CONTROL AND ACCOUNTING SYSTEM OF THE HEAT ENERGY**

**Summary:** The given work proposes the approach to the software development for the system of the complex accounting, registration and analysis of the heat energy consumption for the public utility company "Heat supply of Odessa". The given system resolves the task of uniting the fragmented hardware components into an integral whole. The main characteristics, components and functionality of the software under consideration have been evaluated. The system has an option of providing the heating energy consumers with the convenient on-line resource for obtaining the information and paying the bills for the consumed heating energy.

**Keywords:** automated control and accounting system of the heat energy, a heating meter, software, Web-portal, user's personal account or cabinet

## **ROZWÓJ OPROGRAMOWANIA DO KONTROLI WYDATKÓW ORAZ ZARZĄDZANIA OGRZEWANIEM**

**Streszczenie:** W pracy przedstawiono oprogramowanie systemu kompleksowego rozliczania, rejestracji i analizy zużycia energii cieplnej w przedsiębiorstwie użyteczności publicznej „Heat supply of Odessa”. System konsoliduje poszczególne składniki w całość. Ocniono funkcjonalność oprogramowania. System posiada ocję kontroli oraz zarządzania on-line.

**Słowa kluczowe:** zautomatyzowany system kontroli i rozliczania energii cieplnej, licznik ciepła, oprogramowanie, portal internetowy, osobiste konto użytkownika

### **1. Introduction**

In Odessa (Ukraine) with its population of nearly 1 mln citizens, 95% of consumers are covered by the centralized heat supply system. The public utility company "Heat supply of Odessa" (PUC "HSO") is considered to be the leading company in producing, transporting and supplying the heat energy. On the grounds of the

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company business process analysis we can make a conclusion, that for quite a long time the employees of the PUC “HSO” had to perform a huge amount of mundane work on accounting the heating meters, located in dwelling houses, collecting meters’ data and taking stock of the data in paper form with its further storage in electronic format. Company’s lack of the automated system for recording the device readings as well as lack of energy supply accounting systems for consumers led to the misuse of the human resources. The authors, having conducted the technical analysis together with the software and hardware base, used at the PUC “HSO” now, have proposed and developed the prototype of the distributed control and accounting system of the heat energy.

After modernization of the hardware component of the heat energy consumption system, which resulted in installation of the new modern devices, transferring the data to the server automatically with the time interval of 1 minute, there arose the necessity to create the software for the automated control and accounting recording of the consumed heat energy. In the present work we propose the approach to the development of the software for the system of the complex accounting, registration and analysis of the consumed heat energy for the PUC “HSO” in compliance with the ergonomic requirements and user-friendly and intuitive WEB- interface.

The article provides the main technical capacities, automation stages, a newly-developed interface and consumer - operation algorithm. The system modeling and development gave the possibility to optimize the time spent on consumer service.

## **2. Hardware-software structure of the automated control and accounting system of the heat energy**

The automated system is geographically distributed and unites fragmented hardware components into one integral whole. It consists of a lot of hardware components, united with each other by the data links and software, each of them serving its own function and solving the task within the system of collecting data from the metering devices, i.e. heating meters. The system ensures the hardware components performance, their interconnection, transferring, storage and analysis of the information, received from the metering devices, data exchange with the external systems, operating the actuators and interaction with the end-use customers with the help of the client software.

For data transferring and heat meters’ performance control applying the special software, 3G GSM/GPRS modems, installed on the heat meters for transferring data to the remote server of the Central Control through 3G/GPRS [1] channels are used. GPRS connection is the most frequently used type recently and has the following advantages: a high level of data protection, moderate cost of data transferring, good scaling, allowing to connect simultaneously with the huge quantity of modems. GPRS connection is also convenient due to the fact that in case of correct setting-up it is infallible, does not require constant servicing or special channel allocation. The relational UCDB Firebird [2] is used for data storage on the server.

The software for the automated accounting system of the heat energy must have advanced functional capacities on the level of the user (consumer), that is why a particular attention was paid to the availability maintenance of the WEB-interface

with the intuitively understood structure and enhancing the service functions (electronic payment receipt, ability to pay using the private cabinet and so on). Thus, the functional capacities of the automated system are divided into two subsystems:

- Web-automated working place (Web-APM) of the operator PUC “HSO”;
- Information Web-portal of the PUC “HSO” with the user’s private account.

The hardware-software structure of the automated control and accounting system of the heat energy is shown in Fig.2

At the design stage and at the stage of the system development the modern software methods have been used: HTML5, CSS3, programming languages PHP i JavaScript [3], JQuery library, UCDB MySQL, content management system CMS Joomla (at the customer’s request) [4].

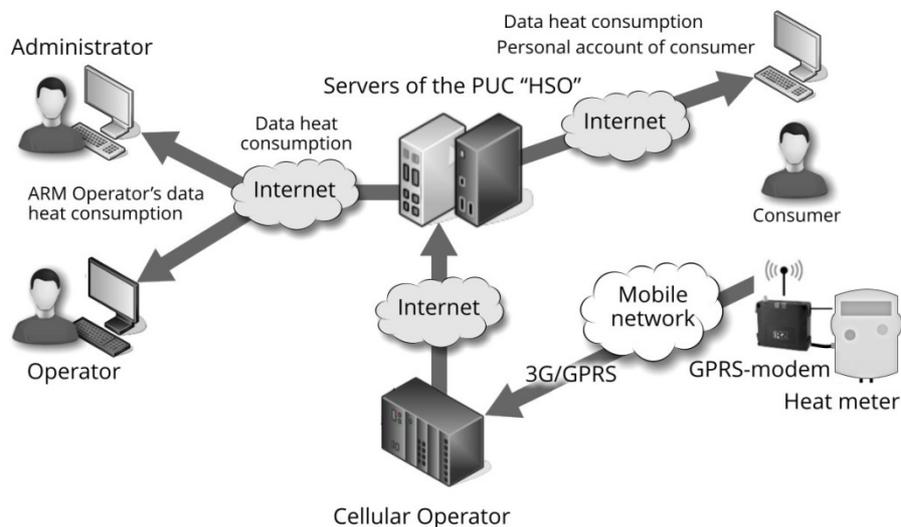


Figure 1. Hardware-software structure of the automated control and accounting system of the heat energy

### 3. Functional capacities of the accounting and control automated system of the heat energy

#### 3.1. Web-automated working place of the operator PUC “HSO”

The functional capabilities of the subsystem Web-APM of the operator PUC “HSO” are oriented at the following groups of users:

- Administrator, for whom all possible system functionality is available, such as the function control and adding new meter devices;
- Operator, who can only view and edit the information about meter devices.

Fig.3 represents the page with information on meter devices. In the block on the left you can see the heat meter list, pagination for its comfortable viewing ability and heat meters search by the serial number or address of installation. When choosing a specific

meter device the right-hand block drops, where the operator can add the meter device readings taken for a specific date.

The meter readings history taken for any time period can be viewed as well.

For your comfort you can add your phone number for making enquiries in case the device is broken, the failure indicator is also at your disposal. Below you can find the meter readings dashboard for a period indicated by the operator. A button for graph construction for an indicated period is also available, as well as a button, opening the map with all meter devices on it (Fig. 3). Among the available options for administrator – the option of adding a new meter device to the OBD system.

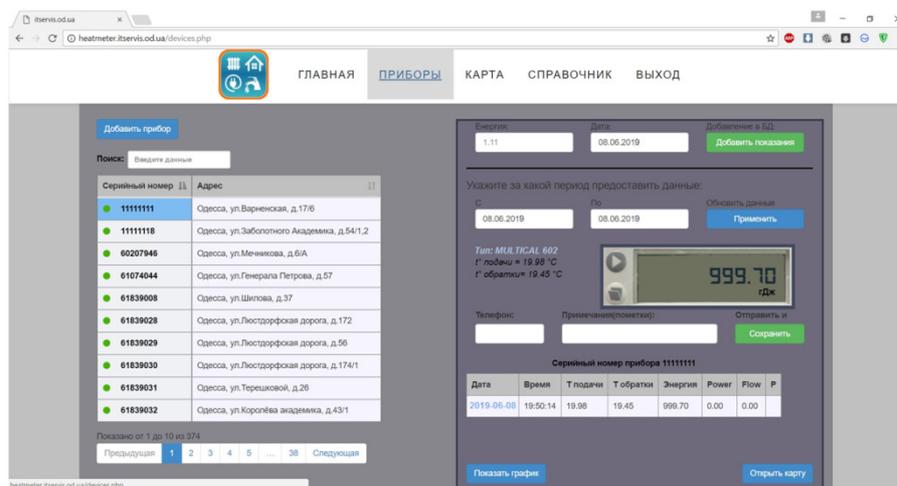


Figure 2. Web-APM of the operator PUC “HSO”: page of meter devices

The location addresses of all company meters are highlighted on the map. The meter devices, which have been sending their data to the OBD system for the last three days are highlighted in green color; the ones, which sent the data to the OBD system at least once, but not later than within the last three days - in yellow color; the ones, which have never sent any data to the OBD - in red color. The map is scaled and the information is available for viewing per each separate meter device: its full location address, the energy supply temperature, the reversal supply temperature and energy.

### 3.2. The information Web-portal of the PUC “HSO” with the user’s private cabinet

The functionality of the Web-portal of the PUC “HSO” is oriented at the following groups of users:

- Among all possible system functional capacities, available for the administrator, are: registered users monitoring, option of adding the news, content update at the static portal pages (information change/update of purchasing plans, information on the service tariff changes, information about the structure and company contact details, information about financial reporting, information on the change/adding the data to the users ‘private cabinets’);
- The user, registered in the system, can have access to the private cabinet based on the private account’s number and based on the surname, which is assigned

- for a given private account. Information, available for the user: address, information on perks, quantity of registered people, apartment area, current month payment, subsidies and debt. The user can get the invoice and repay it;
- The user, not registered in the system, can view the information regarding the company, and navigate to the registration page as well as creating his account on the site.

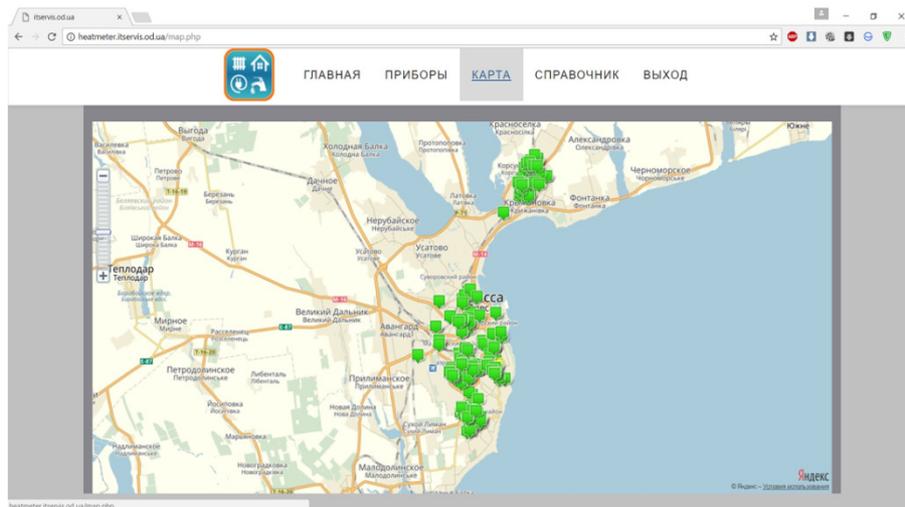


Figure 3. Placement map of the meter devices

Database structure of the user's private cabinet is given in Fig. 4.

The table USERS stores data about all Web-portal's users, namely: a name, surname, email, login, password (in a hash view), withdrawal/blocking condition at the Web-portal, whether the email with confirmation was sent or not, date of registration, date of the last visit, whether the user confirmed his email, date of the last user's password reset, etc.

The table USERGROUPS depicts different user types on the Web-portal.

The table USER\_NOTES stores notes, information about the user, added by the administrator of the Web-portal.

The table USER\_KEYS stores the keys cookie.

The table USER\_PROFILES stores additional information, which could have been added by the user in the optional fields during registration: address, city name, post code, phone number, web-site.

The table USER\_ACC stores the code, the surname and account id number of the user, to whom the private account is bounded.

From the main page of the Web-portal of the PUC "HSO" a registered user can get to his private cabinet (Fig. 5). The upper part of the user's personal account page contains the following information: the surname, address and personal account number. There is the button of deleting the personal account, in case the owner of the personal account has no relations with this personal account anymore. Below we can see the table of monthly charges, divided into the columns: name of the month, number of people, area of the company premises, the amount payable, the sum paid

in the current month, the total debt as of the end of the current month, and also specific information on the financial assistance, compensation and subsidies. For the user's convenience the charges are divided taken for a separate year. The list of all available for the viewing years is represented in the pagination form, when choosing it the list of charges for a corresponding year drops without restarting the page.

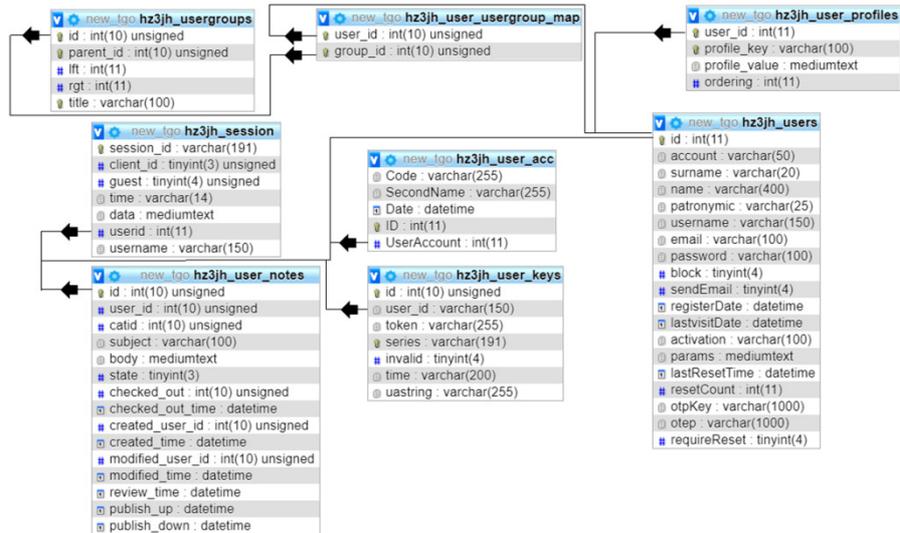


Figure 4. Database structure of the user's private account

Лицевой счёт - 2803004086  
 ФИО Владельца: Джангирова Екатерина Викторовна  
 Адрес: Академика Заболотного вул., д.4, кв.86

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Начисления								
Мес/год	Кол-во человек	Площадь	К оплате	Оплата	Мат. помощь	Компенсация	Субсидии	Долг
Октябрь 2018 г.	1	60.4	0	766.51	0	0	0	0
Сентябрь 2018 г.	1	60.4	0	100	0	0	0	766.51
Август 2018 г.	1	60.4	0	100	0	0	0	866.51
Июль 2018 г.	1	60.4	0	100	0	0	0	966.51
Июнь 2018 г.	1	60.4	0	100	0	0	0	1066.51
Май 2018 г.	1	60.4	0	200	1200	0	0	1166.51
Апрель 2018 г.	1	60.4	137.86	100	0	0	0	2566.51
Март 2018 г.	1	60.4	867.54	100	0	0	0	2528.65
Февраль 2018 г.	1	60.4	836.75	0	0	0	0	1761.11
Январь 2018 г.	1	60.4	924.36	849.14	0	0	0	924.36

2018   2017   2016   2015   2014   2013   2012   2011   2010   2009   2008   2007   2006

Figure 5. Private account page in the user's private cabinet

The payment receipt is formed taking into consideration the total sum of the debt in accordance with the given private account. Based on this payment receipt the consumer can create the bank transfer to repay the debt. The receipt form ready for printing is presented in Fig.6. All information, shown in the receipt, is generated with the help of the saved procedures in a remote database and can be further used for on-line payment.

Комунальне підприємство "Теплопостачання міста Одеси"		КП "Теплопостачання міста Одеси"	
РАХУНОК за послуги теплопостачання		65110, м.Одеса, вул.Балківська 16	
О/Рахунок: 2803004086		р/р 26037301416451 в філії Одеське ОУ АТ	
Кому: Джангірова Катерина Вікторівна		"Ощадбанк", МФО 328845, код ЄДРПОУ 34674102	
Куди: Академіка Заболотного вул., д.4, кв.86		ІПН 346741015014, серія №40380750	
Для звірки ЗВЕРНУТИСЯ: ул.Варненская 27, каб. 114-116		О/рахунок: 2803004086	
Розрахунковий період: октябрь 2018 г.		ПОВІДОМЛЕННЯ ЗА: октябрь 2018 г.	
		Кому: Джангірова Катерина Вікторівна	
		Куди: Академіка Заболотного вул., д.4, кв.86	

Площа м²	Прожив. люд.	Наявність пільг	Борг на початок періоду	Сплачено за період	Тариф, грн.	Нараховано за період	Разом за період	Субсидії	До сплати
60.4	1	0%				0	0	0	0
Опалення			766.51	766.51					
Гаряче водопостачання									

Дані лічильника абонент заповнює САМОСТІЙНО!

Гаряче водопостачання з лічильником (заповнюється платником) (Зазначаються показання лічильника, навіть якщо попередні та поточні показники)	Поточні показання	Попередні показання	Витрата	Всього витрачено	До сплати

**Разом до сплати 0**

Борг на початок періоду	<b>766.51</b>
Нараховано за період	<b>0</b>
<b>Разом до сплати 0</b>	

Figure 6. The payment receipt

#### 4. Conclusion

Therefore, the work describes the development stages of the new original software for the automated control and accounting system of the heat energy, created in compliance with the PUC "HSO" requirements and consisting of 2 subsystems: Web-APM of the operator PUC "HSO" and information Web-portal PUC "HSO" with the private cabinet of the user [5–7]. The following functions have been implemented in the system: registration, authorization, password recovery, data protection, maintenance and adding the heating meters, creation and deletion of the user's private account, receipt printing-out and on-line payment. At the current time the presented automated system has been successfully tested and implemented at the PUC "HSO".

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