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ПРИКЛАДНЫЕ ЗАДАЧИ

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WEB-BASED ACCESS TO TECHNOLOGICAL INFORMATION IN MONITORING SYSTEMS OF ENERGY CONSUMPTION OBJECTS

S.N.Glagolev, A.V. Belousov, Y.A. Koshlich, A.B. Bystrov

We represent top tier of multilevel web-based testing ground technology for energy saving initiatives, that was developed in V.G. Shukhov's BSTU and serves as a power consumption monitoring and visualization system. We describe rationale behind system structure, explaining advantages brought to the ground by utilizing information access mechanics known as reverse AJAX.

The ultimate goal of any monitoring system is to provide access to technological information when it's needed within time-frame as small as possible.

Among the current lines of advance in the area of reducing spatial boundaries and temporal lag of system operator's data awareness, there is a rapid process of thorough utilization of web technologies, associated with their increasing presence in all aspects of control and automation of engineering power systems and facility power supply.

Benefits are ensured by the active expansion of Web technologies: following the standards of World Wide Web Consortium makes it possible to build energy-efficient monitoring systems with the minimized requirements to the client.

Fundamentally, this approach represents natural development of the thin-client idea. Following this paradigm involves conveying of technological information about the state of energy facility to the user by means of TCP/IP protocol stack. Requests for data and commands are carried out with a user-agent (such as web browser) on the client machine. The latter point makes it possible to monitor the status of an object with any device, including mobile ones, which is equipped with communication means adequate for connecting to the Web server [1].

The demand for the well-timed data corresponds to dynamic principle of client-server communication. Conveying information to the client should occur without urgent reloading of entire HTML page. This requirement contradicts with original concept of HTTP protocol data exchange, when when every client opens new connection for every single request, and then closes it immediately after receiving a response from the server. This approach eliminates the possibility of the partial update of the requested page without further advancement [2].

Approaches to partial update and persistent HTTP connection have passed several evolutionary stages of development, each of which is reflected in the modern monitoring systems.

At the time being, among the most widely used ways of operation we can single out schemes developed around exploiting Java virtual machine environment, and schemes based on asynchronous request processing known as AJAX (Asynchronous JavaScript And XML) (Fig. 1).

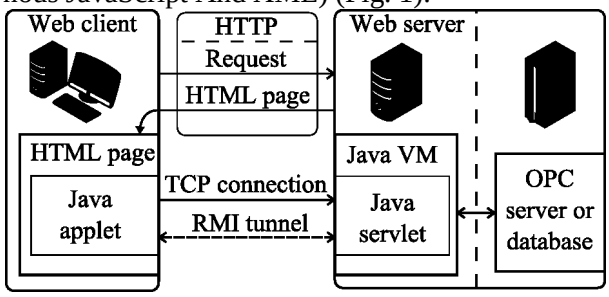

Figure 1. Scheme of access to technological information through a Java-applet

Java-based approach has gained its popularity due to the fact that in the past years it has been almost exclusively providing opportunity to build event-driven client-server interaction mechanism with no need for data polling from the client, in which data travels directly to the client at the moment of state change. In this case, information is transmitted to the client in a separate TCP connection, opened by the server at some additional port. Notion of additional port evokes difficulties for the any client functioning behind a firewall. Moreover, with RMI (Remote Memory Invocation) protocol, which is usually used as logical medium for status updates, it's preferred to choose port randomly.

Another downside is client-side Java virtual machine itself. Its web browser plug-in is one of the most notorious targets for network attacks, and a source of many corporate security vulnerabilities.

AJAX approach is inherently devoid of these drawbacks (Fig. 2), but in the classic implementation this technology does not allow server to send updates to clients at arbitrary moments of time, determined by the server, as communication is done via HTTP 1.0 (request-response). This deficiency makes it necessary to send regular clients' requests, thus increasing network's traffic and server hardware load in case of high polling rate

and large number of simultaneously served clients.

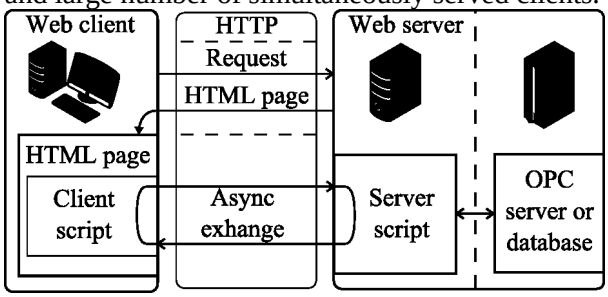

Figure 2. Scheme of access to technological information using AJAX

Widely used approaches also include ones, based on Microsoft .NET technologies, such as ASP.NET or Remote Scripting. In both cases, as well as with AJAX, only HTTP protocol is used, so it is hard to achieve the event-based updates of thin client. But most crucial negative point, undermining benefits of otherwise well established technology, is its rigid binding to a particular software platform [3].

To solve these problems, we've incorporated method that involves the use of reverse AJAX technology with long poll (Fig. 3).

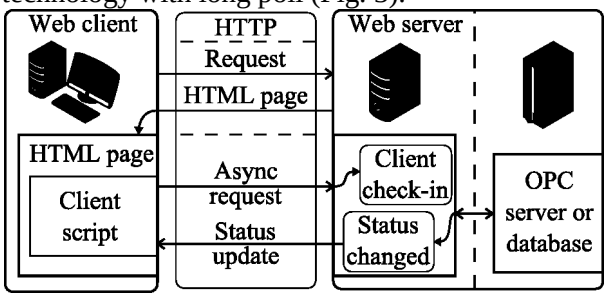

Figure 3. Event-driven access based on the reverse AJAX

This scheme of a client-server interaction can be described as follows. After loading the static data from web server (the page itself, images, client-side scripts, etc.), the client sends an asynchronous HTTP request with the information that determines its current status. The web server records this state, leaving the HTTP connection open, so registration of the client for the next update is done. Server application, acquiring data from the object's sensors notifies web server of the next state change. Information about this change is sent by a web server to the client, and then client closes connection.

The fact that the connection can stay open for a long time, allows:

- relieve the client from the frequent sending of regular requests, reducing the load on the network and the server;

- reduce the system response time: the client receives the updated data without delays induced by the creation of new connection.

In this case, reversion property of AJAX means that responsibility and initiative of polling and pushing is transferred from the client to the server: the server solely determines the moment time for sending updates to clients. It is not required to use any non-standard ports for additional connections, or any browser extensions or plug-ins on the client side.

This approach is sometimes alternatively referred to as Comet AJAX, however, there is no established common terminology.

Promising alternative to the use of reverse AJAX is WebSockets technology, specifications of which are being developed by the W3C as part of HTML5 standard recommendation. WebSockets provides a way of implementing asynchronous update mechanism for particular sections of the page driven by server-generated events at arbitrary moments of time. Their prominent drawback, which undermines benefits this technology could bring to the ground in the current implementation of the system, is poor and unstable support of the standard by the present-day generation of browsers. In the nearest future, however, the situation is likely to change for the better.

Python was chosen as the language of the server application development, due to its intense and steady development over the last few years, the outstanding expansion options, and the relative simplicity of interaction with the OPC servers by means of additional modules.

Organizing the communication via OPC was implemented using the openly distributed by public license OpenOPC module for Python. Communication with OPC server protocol is done with OPC-DA 2.05a.

The remote server takes the technological information from equipment sensors via Modbus, providing access to it through the OPC interface.

As the bulk of the data in the system is represented by information about the temperature of individual units, the detention lag of the processes is quite high. Thus, the polling frequency of OPC server is reasonable to be set within a few seconds.

Any common-spread HTTP server, which corresponds to WSGI (Web Server Gateway Interface) protocol specifications, can be used as a web server in this case. Such is, for example, Apache HTTP server with mod_wsgi module. However, more sophisticated approaches, including separation of tasks between fast and tiny HTTP server, which serves static content, and heavyweight back-end server, capable of dynamic content deployment, are preferred ones. Such universally acclaimed separation of duties is well-spread due to scalability issues of single-server approaches. Lightweight front-end server that serves static requests and acts as a proxy, forwarding dynamic

requests to the back-end server, raises throughput of the system, preventing denial of service issues. In our case, separation is achieved by incorporating nginx and gunicorn servers in respective order.

The task of simultaneous processing of multiple client responses is usually solved with execution threads, which web server generates for every registered client. This naturally limits the number of simultaneously processed responses, as construction and elimination of threads are rather demanding operations. Besides, each thread needs a certain amount of RAM.

These reasons have justified the transition to the use of coroutines and gunicorn server. Coroutines are not only devoid of the aforementioned drawbacks, but also evoke lesser risks of error induction in the development process, as the points of control transfer between coroutines are explicitly specified by the programmer, and therefore are known in advance, unlike the situation with threads, when control is transferred at arbitrary points of time determined by the operating system.

As a result, the operator receives state updates via HTTP, using a web browser as a client. The only requirement is the permitted implementation of scripts, implemented in JavaScript language, by user-agent, as the client part of the whole system is based on them. This requirement can't be considered as burdensome due to omnipresence of JavaScript in modern web.

Described approach has been implemented in a system of monitoring energy consumption of distributed technological objects of Belgorod Shukhov State Technology University. Resource located at http://ntk.intbel.ru/energo.

Developed system incorporates three interconnected tiers of operation (Fig. 4). The lower level of the system is represented by electricity power meter Mercury 230, which can measure up to fifteen parameters characterizing energy consumption and quality of power supply: active power, reactive power, voltage, current and frequency in each phase.

Utilization of AR-03 variant of Mercury 230 makes it possible to use existing RS-485 interface for communication with intermediate ICPDAS I-7188EXD PLCs to acquire technological data from the local control and monitoring devices.

Industrial controller purpose is to monitor state of regulated technological parameters. Controller software harnesses ModBus communication protocol to acquire data, and makes it available for top level equipment. PLC acts as an RS485 interface converter in this case, and all the antics of communication between controller and top level equipment of the system are managed by means of developed controller software. I-7188 controllers were chosen as mid-tier communication controllers for this particular system, as they provide convenient way of organizing information exchange with Mercury power meters, including checksum calculation, managing security access levels of configuration parameters, system time manipulation and fee adjusting commands).

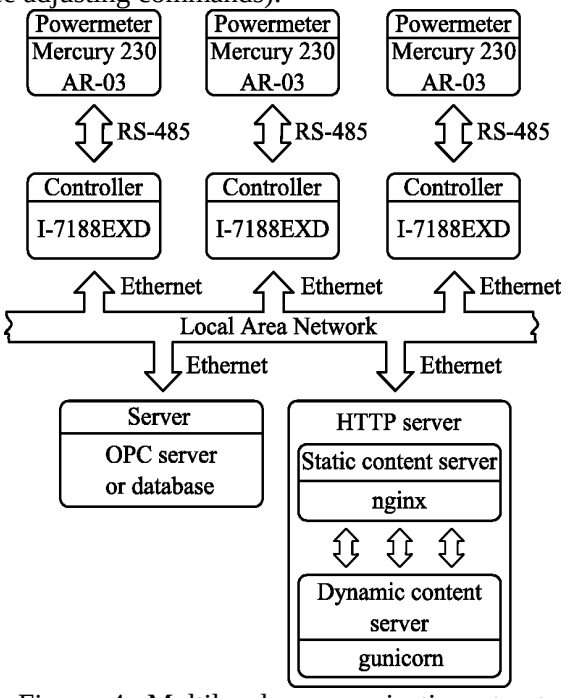

Figure 4. Multilevel communication structure of energy consumption monitoring system

We can divide all programmed requests into four groups:

- test of communication channel;
- communication channel open/close requests;
- write requests;
- read requests.

I-7188 controller conveys information considering current power consumption to University's local network via Ethernet interface, by means of ModbusTCP protocol. System monitors specified parameters provided by Mercury power meters:

- system date and time;
- power supply mains frequency;
- current by phase;
- voltage by phase;
- power factor by phase;
- active power by phase and summary for the current day;
- active power by phase and summary for the current year;
- active power by phase and summary for the previous day;
- active power by phase and summary for the previous year;
- active power integral value;
- reactive power by phase;
- reactive power summary;

- status of the connection;
- electricity price.

OPC-server is used as an intermediate communication node between controller and top level equipment, represented by HTTP-server.

Visual representation is performed by client-side agent, such as web browser. Data necessary for representation is fed to the client agent dynamically. As a result, developed web-based monitoring and visualization system fully complies with demands for modern automated power consumption monitoring systems, providing:

- automatic acquisition of power consumption data for each point of accounting;
- relational database driven storage engine;
- multi-rate metering of electricity power consumption;
- on-demand data representation;
- maintaining unified system time with adjustment option.

At the time being, system is in the middle of active development process, with design goal of making it possible to integrate power consumption data analysis and real-time decision making support, which will help to assess actual performance of distributed objects, and simplify developing and deployment of organizational and technical actions, aimed at energy consumption optimization.

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ОБРАБОТКА АУДИОДАННЫХ В ЗАШУМЛЕННЫХ КАНАЛАХ СВЯЗИ

О.С. Жигалов, Д.С. Шемончук

Обсуждается обновленная методика обработки аудио данных в инфокоммуникационных сетях на основе технологии Audio Data Mining. Методика позволяет извлекать текстовую информацию из зашумлённого канала связи с точностью до 93% за счет модифицированного алгоритма семантического поиска.

В настоящее время большой объем информации хранится в виде цифровых аудио файлов. При этом корректный поиск информации в них сильно затруднен, а порой невозможен, поскольку стандартные механизмы поиска по ключевым словам и по темам, заложенным непосредственно внутри текстовой статьи, не подходят для поиска среди сильно зашумлённых аудио файлов. В качестве одного из примеров таких аудио файлов авторы рассматривают аудио файл с речью и наложенным на него музыкальным сопровождением.

Большинство статистических методов для выявления взаимосвязей в данных используют концепцию усреднения по выборке, приводящую к операциям над несуществующими величинами. Технологии оперативной обработки данных, в том числе OLAP-технологии, больше подходят для расшифровки ретроспективных аудио данных. В тоже время активно находит себе применение технология распознавания аудио данных, известная как Audio Data Mining [1] (одна из разновидностей Data Mining), которая, опирается на ретроспективные данные для получения ответов на вопросы о будущем, оперируя реальными значениями в настоящем. Эта технология во многих случаях позволяет оперативно и качественно осуществить поиск информации внутри широкого спектра аудио записей.

Особенно быстрыми темпами технология Data Mining развивается в областях, связанных с решением следующих перспективных задач:

- формализация эвристик в типизируемых предметных областях, облегчающих решение задач с применением технологии Data Mining;
- создание формальных языков и логических средств, с помощью которых осуществляется формализация и автоматизация контента в типизируемых предметных областях;
- создание методов, способных не только извлекать закономерности из обрабатываемых данных, но и формировать новые закономерности и теории, опирающиеся на эмпирические данные;
- развитие инструментальных средств Data Mining с принципиально новыми возможностями адекватными теоретическим достижениям в области оперативной обработки аудио данных.

Тем не менее, для полноценного использо-