ISSN 0005-1179, Automation and Remote Control, 2016, Vol. 77, No. 6, pp. 1122–1128. © Pleiades Publishing, Ltd., 2016.
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AUTOMATION IN INDUSTRY

Organization of Energy Resource Monitoring on the Basis of XML Protocol

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Received April 7, 2013

Abstract—The architecture of an integrated energy monitoring system is discussed. Merits and drawbacks of various data interchange formats are described. Basic types of the information transmitted in the system are pointed out. Key principles of XML messages formation are shown as well as various aspects of subject area influence on the XML protocol structure.

DOI: 10.1134/S0005117916060175

Today development of microprocessor equipment and information technologies allow to provide automation of process control of any branch. The power industry is one of the major branches providing functioning of activity both the certain individual, and society in general therefore the special attention is paid to automation of this branch.

One of the main expenditure items by production are costs of the consumed energy resources (the electric power, heat, water, gas, etc.) therefore at continuous increase in prices the problem of management of energy resources becomes more and more actual. Knowledge of volumes and profiles of consumption of energy resources (where, who, when, how many) allows to cut expenses, to optimize constant actual costs and to increase energy efficiency of the enterprise. On-line monitoring of consumption or sendout of energy resources allows to establish in time the reasons of imbalance, an overconsumption, sharp increase in losses when transporting. Existence of full actual information on system gives the chance of adoption of the correct management decision in non-standard situations [1, 2].

The modern automated systems providing dispatching, technological and technical control, and also energy monitoring of resources, operate the distributed objects which can settle down on considerable distance from each other and be in certain relations among themselves and with environment. All this causes that systems of automation are territorially distributed, multilevel and are designed by the hierarchical principle. The architecture of the complex energy monitoring system consisting of several logical levels is given on Fig. 1.

• *Level of collecting* involves primary measuring devices and data acquisition and transmission devices (DATD) which are carrying out the round-the-clock collecting from territorially distributed devices, accumulation, processing and data transmission on top levels.

• *Level of processing* involves the server providing collecting registration, technological and event information from DATD (or DATD groups), and also processing and storage of these data. The server part provides access to a DB and processing of inquiries of clients. At this level data transmission on other servers can be carried out.

• *Station level* involves workstations at which display of information in the form convenient for the analysis and decision-making (management) is carried out [3].

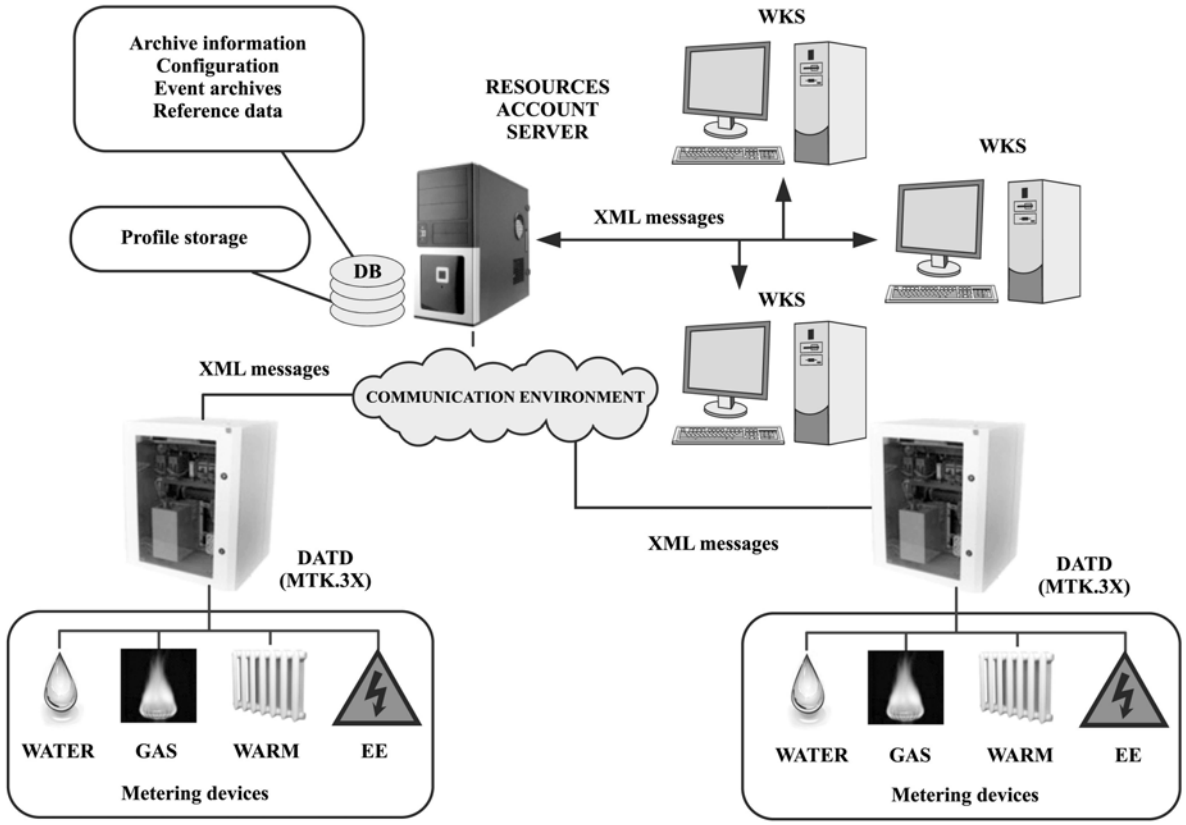

Fig. 1.

Data exchange in the distributed hierarchical systems becomes one of the major elements. Until recently exchange of information was carried out in a binary format. Such approach considerably reduces traffic of communication channels and simplifies coding and decoding. It is logically possible to allocate two levels: container and data. The first level provides integrity and reliability of data transmission, availability of detection of the message in a byte stream. The second level contains the sent data.

In the industry unified CRC-RB protocol applied at an exchange of operational information in the monitoring system and the accounting of electric energy from the DATD level in the centers of collecting and data processing automated power supply monitoring and control system of the power supplying organizations it is used binary structure of frames of inquiry and the answer.

In a binary format the structure of frames is rigidly fixed, it imposes considerable restrictions on possibilities of development and extension of binary protocols of data transmission. This limit is removed by addition of new frames with the complicated structure. As a rule, it leads only to complication of the protocol as the number of frames is multiplied (the protocol expands in width) as there is no opportunity to change and expand already available frames. Also binary protocols have restriction on word length, for example the protocol written for 64-bits systems can't be applied on 32-bits. At desire to carry out transition with 32-bits on 64-bits version of OS similarly there can occur problems connected with the sizes of fundamental types for various systems.

Development of the ASN.1 standard, formal language of the description of types of data and their values was one of attempts to solve a problem of augmentability of binary protocols. Abstract syntax of ASN.1 allows to define basic objects and then to unite them in more complex, providing a standard way of representation, coding, decoding and transmission. The main advantage of this standard is data transmission in a binary format and use of frames of the protocol of variable

Comparison of formats of data transmission

Characteristics	Binary format	ASN.1	XML
Operational flexibility	law	high	high
Augmentability	law	high	high
Readability	law	law	high
Complexity of program realization of analysis and formation	law	high	law
Load of communication channels	law	mean	high
Costs of computing capacities of coding and decoding	law	high	high

length. It is possible to carry to shortcomings that this approach is difficult both from the logical point of view, and in practical realization. It is necessary to pay with additional computation power for flexibility of the ASN.1 standard on coding and decoding of data.

Today growth of productivity of networks and capacities of the personal computer allow to build the expanded protocols on the basis of XML. The XML language is the most suitable and perspective means for creation of the interfacing protocol (table).

The most significant advantages of XML are:

• expressive power sufficient for the description of data practically any complexity;

• possibility of structuring and creation of hierarchical links between data;

• the augmentability allowing to modify and complicate easily the protocol in process of development of system;

• flexibility of a format of exchange of information that facilitates the accounting of distinctions in versions of data, and also maintenance and data transmission between various systems;

• platform independence;

• existence of a certain syntax and requirements to parse that allows XML to remain simple, effective and consistent;

• standard analysis of XML messages;

• possibility of the information processing issued in the form of XML, not only by machine, but also by the person [4].

Possibility of control of data by the person at the level of the protocol is essential advantage as allows to exercise debugging and control of work as systems in general, and its separate parts. It follows from this that the structure of the XML protocol has to be cogitable the person, and it is possible only in that case when XML frames are correctly designed and thought over.

When try to transfer the old binary protocol to XML, leaves not really successfully as the received format isn't read by the person and considerably complexity of program realization of analysis and formation of the unstructured, not unified XML frames increases. The structure of the XML protocol needs to be thought over in details.

The logic of operation of application usually is under construction round exchange of information, and thus it is desirable to have a uniform universal format of data. The bad worked architecture of the XML protocol complicates development and realization of system.

Complex systems of automation of power facilities are put into operation gradually, over time extend and modified, and also have the long term of operation therefore the protocol of data transmission for them has to be expanded and universal at all levels.

It is necessary to pay considerable volumes of transmitted data on a network for use of XML (XML very excess language), and also costs of computing capacities of analysis and formation of XML files that at a modern level of development of the microprocessor equipment is insignificant. And where a bottleneck is the network, it is possible to apply algorithms of compression of information.

Authors developed the protocol of an exchange of registration and technological information for complex system of the accounting "Energoresurs" on the basis of XML. In this article experience of creation and implementation of the expanded XML protocol is analyzed.

When developing specifications of the communications protocol the task as much as possible to unify and simplify the XML-format of messages was set. In system of the accounting of resources the following main types of data were allocated:

• regular archives. Archival data represent calculated data—instrumental indication on the basis of which volumes of consumption of resources in an account point are determined by the device for various periods of time;

• poll commands—it is requests from the server to DATD and from the client to the server on archival information;

• event archives. The system fixes any events in logs. The part of data on events on the server is stored in a XML format that considerably simplifies processing, storage and further data transmission. Logs share on DATD events, metering devices, points of the account, an event of system;

• configuration information: the system contains data on users, about topology of structure of object, parameters of system, etc.;

• commands of change of a configuration;

• the glossary of devices (calculators) which are known by system;

• reference information about metering devices and DATD;

• information on a device status and DATD [5].

On Fig. 2 the partial scheme of the developed and realized XML requests from the client to the server is shown.

Archives records include accounting and technological data, as well as logs. Accounting data can be requested as archive (minute, half-hour, hour, daily, monthly), in concrete units of measure or in values by default, namely in those units in which data come from devices. Also the client can request data on concrete parameter or archive entirely. Logs can be requested on the metering device, on an account point, on DATD, on system. Administration includes commands for creation, change, removal, a attaching, detaching and obtaining the list. The client can create, delete, change the metering device, a point of the account, DATD, balance group, node in topology. The metering device can be attached/detached to a point of the account, DATD; similarly it is possible to tie a point of the account or DATD for formation of topology of system to note of a tree, etc.

Format XML of requests/responces for transfer of accounting and technological information between levels (DATD $<->$ Server, Server $<->$ Client) in system of the accounting of energy resources has a uniform format.

During functioning of system metering devices can fail and their replacement can be made, but at request of data on a metering point the operator has to obtain data both from earlier installed device and from the present one at the indication of the time span including time of replacement of the counter. This opportunity is provided at data transmission in a XML format: the identifier of the metering device which possesses data is specified in archive.

On the basis of this format in system additional reports of an exchange of archival information are developed:

• on a point of the account to give out a certain type of archive;

• to give out a certain type of archive on a metering point and certain number of parameter;

• to give out a certain type of archive on several metering points and/or in several certain parameters;

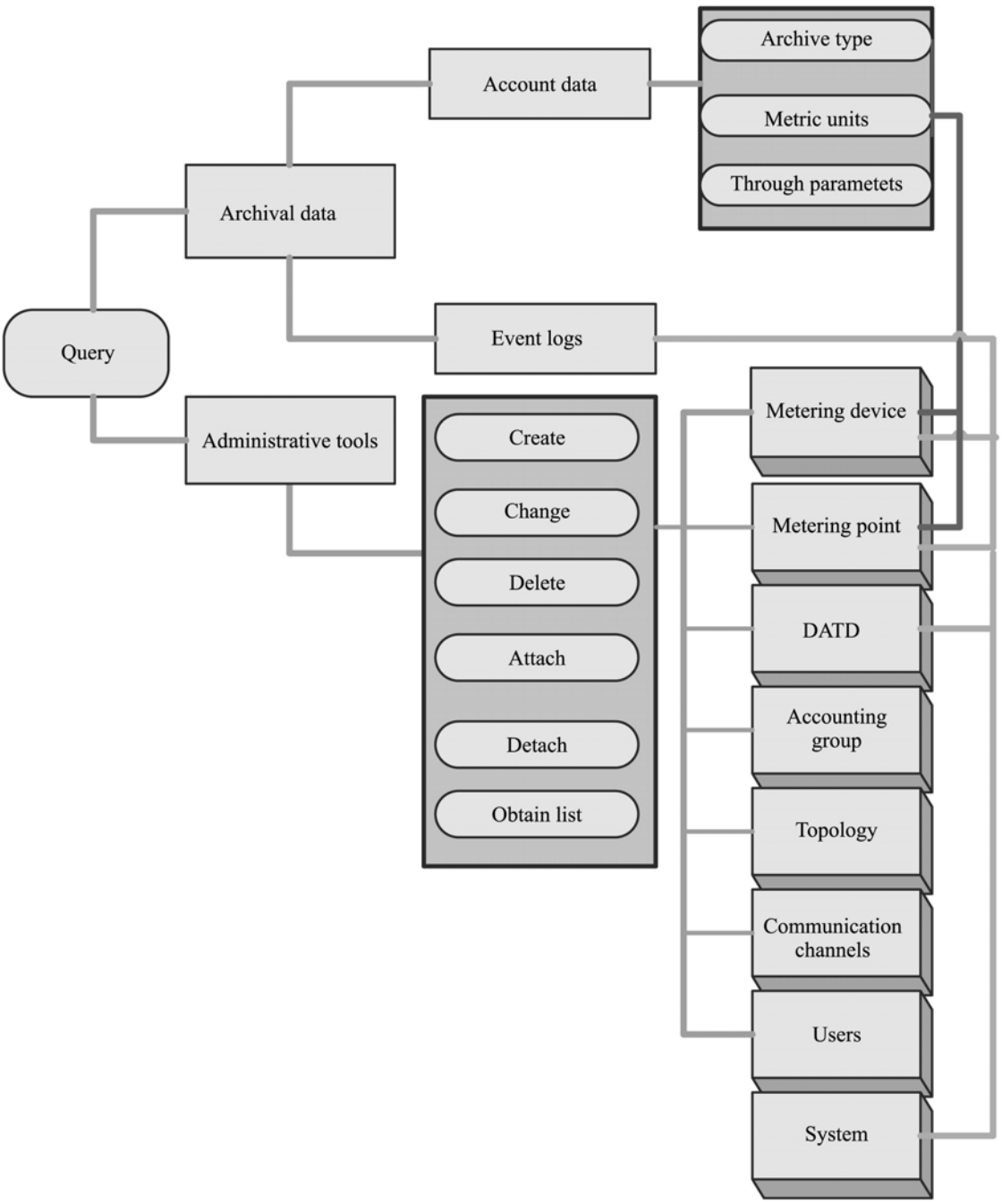

Fig. 2.

• to request archive in certain units of measure;

• to give out a certain type of archive on the metering device and certain number of parameter.

Length of frames in the majority technological protocols is forcibly limited, proceeding from requirements of efficiency of an exchange. It imposes rigid restrictions on data transmission process.

For overcoming of this problem the decision to carry out delivery of large volumes of data in parts was made. For this purpose in the XML answer the XMLPart attribute = "The current part of archive/In total parts it is expected." It allows to transfer as much as large volume of data, overcoming the imposed restriction on length of frames.

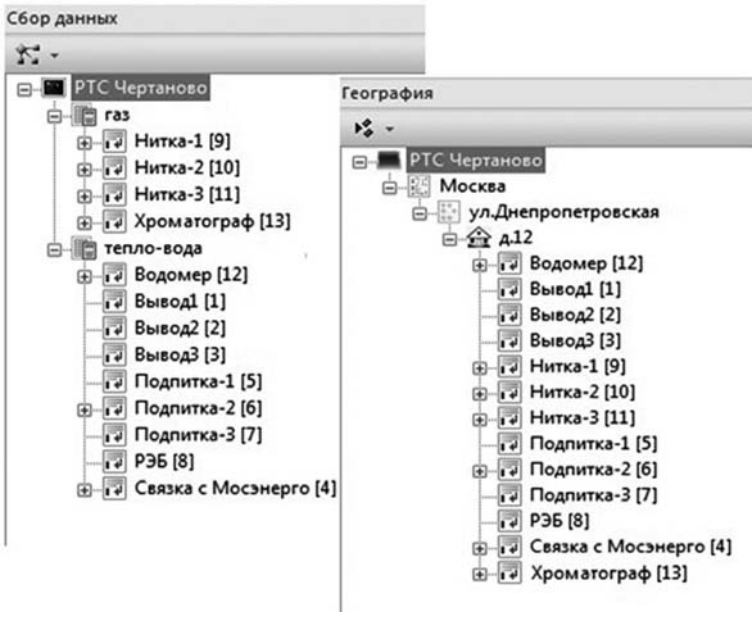

Fig. 3.

The client has to receive a reply to the request for the minimum time, but selection of large volume of data from a DB takes time. As a rule, display of large volume of data to the client's personal computer also is slow. Portion display of data appears the most comfortable for the person as he obtains at once part of data, and other part is loaded in addition then.

When developing a format of data transmission generalization and partitioning of information streams between subsystems, stylization XML requests/responces was carried out.

At implementation of modern systems of automation the increasing attention is paid to questions of simplicity of management of a configuration. Even basic functionality of system means 20–30 operations of a configuration. Earlier all operations were executed by the operator or engineering firm. However modern hardware-software complexes demand the minimum intervention of the person in process of management of settings. It is promoted by increase in speed of communication channels, growth of productivity and functionality of metering devices and DATD.

One of ways of an autoconfiguration is import of configuration settings in the XML format from DATD when opening a communication channel, and also at changes of settings for DATD.

On the basis of the obtained data it is possible to add information on metering devices, transformation coefficients in the automatic mode, to create metering points and to build up data collection topology. Thus, for ensuring data collection at the top level it is enough to describe communication channels with DATD.

General information about hierarchical structure of system of the accounting of resources includes data collection topology, geographical topology, technological topology (infrastructure of system of distribution of a resource), these data are requested at start of the client at successful establishment of communication with the server. The client sends request to the server, on the basis of the received answer builds hierarchical trees of structure of object (Fig. 3).

The developed XML format allows to transfer information on network topology, object of any level of complexity and an enclosure, allows to divide the existing local metering systems of different types of resources from a uniform information field. To each of a tree node there corresponds the unique number. Knowing it, it is possible to request topology from any level that considerably simplifies work with system if the scale of object is great, has consumption, generation, different

Quary:

```
<?xml version="1.0" encodng="windows-1251" ?>
   <Request_Operation XmlId="1\1">
      <Entity>
         <Parameters>Level</Parameters>
         <Parameters>Level</Parameters>
      </Entity>
   <Request_Operation>
```

Answerback:

```
<?xml version="1.0" encodng="windows-1251" ?>
  <Responce_Operation XmlId="1\1">
      <Entity>
      <Parameters>Level</Parameters>
      <Parameters>Level</Parameters>
      </Entity>
      <Status>Information on the status of operation.</Status>
  <Responce_Operation>
```

Fig. 4.

transportation of energy resources, has difficult hierarchical dependence, and also it is territorially distributed [2, 3].

The generalized structure XML requests/responces for a configuration of system by the operator is given on Fig. 4. The analogous structure of a format of the XML protocol is universal.

The developed XML protocol is unified, easily expanded that allows to modify and complicate the protocol in process of development of system without any serious changes. Process of data exchange in system has a uniform appearance at various levels, does system open, universal and expanded.

The gained experience shows that XML really allows to create the readable expanded protocol. All decisions described above are applied in the complex system of the accounting of energy resources "Energoresurs" developed by LLC "SYSTEL." And excessive "garrulity" of XML is compensated by compression of data.

This system is installed on a number of objects of power and the industry, in particular, on Stoilensky GOK information exchange with 32 DATD. For these devices as data sources the Proton, Mercury, SET, Energomer act the 526 counters, on them is carried out half-hour, daily, monthly and annual accounts.

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