

# Digital monitoring system of the Baikal natural water area based on IIS "Kumir-Resource"

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**Abstract.** In this article, the solution to the problem of ensuring the ecological improvement of water bodies, including the Volga River, and the preservation of unique water systems, including lakes Baikal and Teletskoye, is reduced to the creation of a digital monitoring system capable of organizing communication with a large number of devices for monitoring the environmental parameters of lakes and rivers. On such a scale, a well-planned platform will avoid problems in data exchange, provide fast and timely access to information. When creating a platform of this type, a number of requirements and tasks arise, the solution of which can cause certain problems and limitations. To organize a stable connection with monitoring devices in the amount of several million pieces, the IT platform must be scalable and performant. These and other tasks are being solved by the Irkutsk National Research Technical University together with the STC "Kumir".

## 1 Introduction

Today, Baikal is a unique lake on the planet, which needs constant monitoring of the level of pollution, due to the gradually increasing influence of the anthropogenic factor on the ecology of the Baikal natural territory.

In this regard, in order to solve the environmental problems of the most important objects of the country, the President of the Russian Federation adopted a decree instructing the government to fulfill the following tasks by 2024[1]:

1) Ensure the environmental rehabilitation of water bodies, including the Volga River, and the preservation of unique water systems, including lakes Baikal and Teletskoye;

2) Solve the problem of preserving unique water bodies, including implementing a project to preserve Lake Baikal, as well as measures to clean up debris from the shores and coastal waters of lakes Baikal, Teletskoye, Ladoga, Onega and the Volga, Don, Ob, Yenisei, Amur rivers, Ural, Pechora, and, possibly, to develop a system for timely warning and current monitoring of the state of the lake.

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Irkutsk National Research Technical University together with the STC "Kumir" offer their own intellectual platform that organizes the lower and middle levels of the network based on the IIS "Kumir-Resource".

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The information and measuring system of the IIS "KUMIR-Resource" is a communication software and hardware IoT platform with a wide range of applications in various fields of industry, agriculture, ecology, environmental protection and households.

The basic task of LLC STC "KUMIR" in the development of IIS was the creation of a "cloud" system for remote monitoring of readings of heat, electricity, hot and cold water and gas meters. Later, the functionality of the IIS "KUMIR-Resource" was expanded with capabilities for tele-alarm, remote control of controllers and equipment of thermal units, quality control of resources, as well as support for equipment for monitoring environmental parameters.

Further development of the KUMIR-Resource information and measurement network is in line with the comprehensive digitalization of its individual industries, the unification of requirements for individual areas.

## 2 Digital Platform Architecture

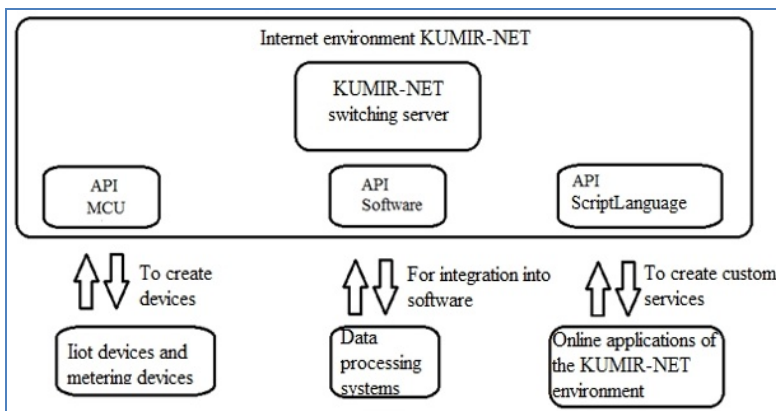
The development of IIS "Kumir-Resource" to the level of a high-speed communication platform based on the "Kumir-Net" protocol and the integration of various services and capabilities of industrial and applied areas based on this platform has no direct analogues in the Russian Federation[2].

IIS "Kumir-Resource" is developed on the basis of the open OS Linux PostgreSQL database.

The system includes switches, GPRS modems, radio channel transceivers and pulse counters operating at a frequency of 868 MHz, allowing for bidirectional communication with monitoring devices [3, 4].

The competitive advantage of the system from STC Kumir is the existing hardware solutions of the company, a high-speed communication core that allows processing millions of transactions, development tools and simple API software libraries that allow you to adapt, develop and connect any proprietary applications to the system [3-5].

The architecture of the KUMIR-NET switching platform is shown in Figure 1.



**Fig. 1.** The architecture of the switching platform KUMIR-NET.

The introduction of such a technology helps to reduce the cost of creating and managing large networks of equipment for solving environmental monitoring problems.

The platform is based on our patented innovative method of transmitting telemetry data over open IP networks, which makes it possible to reduce transaction costs during switching and data transmission [6].

Using our own innovative data exchange algorithm allows you to reduce the number of peripheral devices and reduce the cost of equipment for the entire monitoring system as a whole.

This possibility is inherent in the system architecture and is achieved by using the high-speed Russian in-memory computing platform Tarantool using a non-relational scalable DBMS and traditional SQL Postgres. The use of NoSQL and SQL DBMS is due to the fact that in a running large system there are real-time processes and scheduled processes.

Real-time processes are associated with the storage and verification of large streams of raw data.

Other processes such as data pre-processing, reporting, data analysis and data export can be implemented as scheduled work.

The difference in the times of writing-reading, processing and duration of data storage requires in large systems their separate processing with the involvement of both non-relational and SQL DBMS. This approach optimizes the performance of the system as a whole.

Test results of the latest version of the server software showed a maximum switching speed of about 2 million transactions per second at 2.4 Gbit/s flow rates.[5]

The Tarantool application server used in IIS KUMIR-Resource supports various scenarios of redundancy (mirror geographically distributed servers), database synchronization, load balancing, application clustering and virtualization both for the current mode and for disaster recovery of a distributed system (geo-redundancy) .

The principle of modular platform design allows you to start small and add functionality step by step, in accordance with evolving commercial, procedural and technical requirements.

IIS "KUMIR-Resource" can interact with web services based on REST or SOAP for seamless integration with third-party applications.

The flexibility of the KUMIR-Resource distributed system is given by the use of a high-performance messaging system with support for the "cloud" NATS architecture.

The Grafana open source platform is used to visualize, monitor and analyze data.

Grafana allows you to create dashboards with panels for a specific project, taking into account any development and business needs.

IIS "KUMIR-Resource" allows you to use the system for several organizations in parallel. This allows transactions for multiple network operators on the same system. To do this, IIS "KUMIR-Resource" implements the requirements of secure and controlled data separation based on virtualization on a single platform and logical separation of access rights to devices and data through roles and a permission system.

### **3 Circuit solutions for data transmission**

The circuit design of the IMS Kumir-Resource allows you to use and combine radio channel and wired solutions, depending on the situation.

A specific placement option is developed by analyzing the radio environment, geometry and other parameters, based on the choice of the most economical option.

The undoubted advantage of the IIS "KUMIR-Resource" is the support of end-to-end signal transmission using a single protocol and various communication channels:

- 1) 868MHz radio network,
- 2) wired CAN bus,
- 3) Ethernet network.

To this end, LLC STC "KUMIR" has developed the appropriate hardware and software. This allows, depending on the complexity of the radio environment, installation conditions and economic feasibility, to use unified approaches, equipment and software of KUMIR STC LLC both in open areas and in urban areas.

It should be noted that the wired version is the cheapest and most noise-resistant version. In addition, it is most understandable to installers.

The fact that each communication device is addressable greatly simplifies network maintenance and troubleshooting.

At the moment, a hybrid implementation using a radio channel and a CAN bus is successfully working in apartment buildings, in difficult urban conditions, where installations based on purely radio channel solutions are costly and do not provide a guaranteed result. It can be argued that IIS "Kumir-Resource" already now provides the "field" level of the information-measuring system at the hardware and software levels [5].

The IIS platform "KUMIR-Resource" uses modern technologies and design rules for a large scalable system. An approach is used to virtualize the functional components of the entire system in terms of their functionality, performance and security requirements.

Virtualization is an integrated concept of architectural design of IMS "KUMIR-Resource".

IIS "KUMIR-Resource" supports industry-standard algorithms and protocols for symmetric and asymmetric encryption.

To build a full-scale digital system, the forces of IRNITU and the Institute of Energy Systems named after A.I. L.A. Melentiev, Siberian Branch of the Russian Academy of Sciences.

## **4 Conclusion**

An innovative approach to data processing that meets the requirements of scalability and performance for intelligent platforms allows you to reduce transaction costs, which will increase the number of monitoring end devices to several million pieces.

Using the Kumir-NET protocol for data exchange will result in a low cost for the final system.

Creation of transport layers for the protocol on top of the CAN field bus and on top of the IEEE 802.15.4 radio channel will allow creating the most common and cheapest way of radio channel data transmission.

The organization of the lower-level interface allows receiving data from monitoring devices, transmitting commands and reading technical parameters about the state of the equipment.

The organization of a high-level interface makes it possible to process data through the IIS "Kumir-Resource".

IIS "Kumir-Resource" is a multi-resource system that allows you to work with almost any device for monitoring environmental parameters of the environment that has an open data protocol.

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