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Colibri field data bus Server: dynamic GUI generation and scalable virtual emulation for HART/Colibri devices

R.V. Pushkarskiy[1,2], V.A. Belski [1,2]
Scientific Supervisor: Prof., Dr. A.G. Goryunov[2]
[1]ASPECT LLC, Russia, Tomsk, 37 Saltykova-Shchedrin str., office 18, 634021
[2]Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: rvp6@tpu.ru, vab59@tpu.ru

Abstract. *To solve the problem of supporting intelligent sensors manufactured in the Russian Federation by foreign software, Aspect LLC has developed a "Colibri field data bus Server" software, which supports HART devices and Colibri field data bus devices. "Colibri field data bus Server" works with intelligent sensors and their electronic descriptions.*
Key words: *HART, CDD, Colibri, EDD, EDDL, Qt Framework.*

Introduction

Aspect LLC has developed a "Colibri field data bus Server" (hereinafter referred to as Colibri software), which provides a user interface for interaction of automated process control and monitoring systems with intelligent field devices manufactured both in Russia and in foreign countries. Software supports end-to-end control and diagnostics of field equipment based on the Colibri and HART protocols [1, 2].

Software has passed bench tests for the compatibility of the Colibri protocol with instrumentation and control equipment using HART technology. Compatibility tests with most popular industrial software and hardware used at facilities (Kaspersky Industrial Cybersecurity, ABAK PLC, Regul PLC, zVirt, Cyberbackup and others) [3]. There are two important tasks in development of graphical user interface (GUI) for this kind of software: firstly, it is necessary to create a dynamic user interface suitable for any field device in the industry and secondly, it is necessary to create a dynamic representation of the enterprise structure capable of displaying a large number of field devices.

GUI Creation in Colibri software

For remote configuration and management of intelligent sensors and automation equipment, it is necessary to use colibri device descriptions (CDDs), which are unique to each device model and contain the structure and variables of field device's menu [2], while the configuration environment itself must be universal. So, the first objective is to develop an engine to create universal dynamic user interface, automatically generated at the moment of interpreting the electronic description, which differs from existing solutions by its ability to adapt to any device's electronic description.

This objective was achieved by developing an engine dynamic GUI creation. Fig. 1 shows a diagram of creating a user interface for intelligent sensor. The engine goes through all the menu elements and builds certain GUI structure for different types of CDD elements during CDD interpretation: the variables are input fields, methods are buttons that call certain commands, and built-in functions are dialog windows with input fields or buttons that require user interaction.

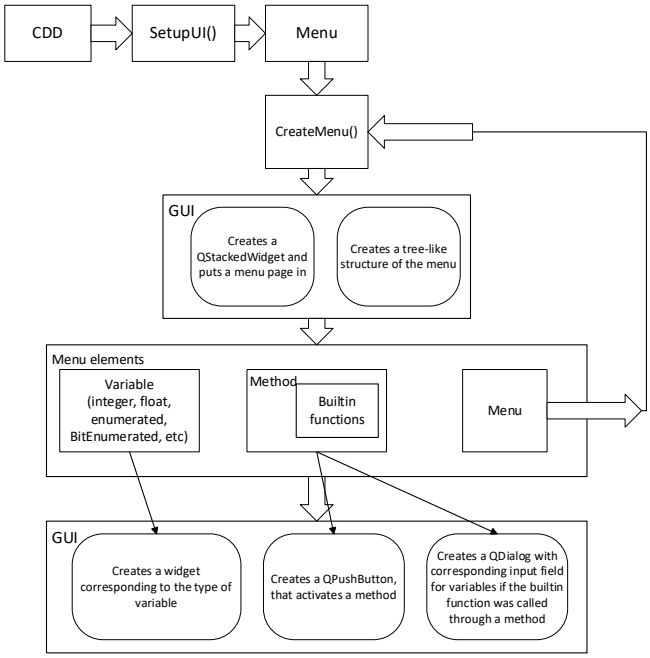

Fig. 1. A detailed diagram of GUI creation

For the second task, it is necessary to create a dynamic representation of the enterprise structure capable of displaying a large number of field devices, with support for grouping, sorting, and editing. This was achieved through QTreeWidget and JSON files that store a tree structure [4]. Work is underway to implement several structure representations options, providing users the ability to save and utilize customized device trees that are most convenient for them. In the Fig. 2 an example of such tree is presented. Each element of the tree is draggable, and could be moved into folders that are created by user. In the Fig. 2 such folders are «АБАК ПЛК», «Новые устройства», «Regul R500», «Samson». The number of nested folders is not limited in the current type of enterprise representation.

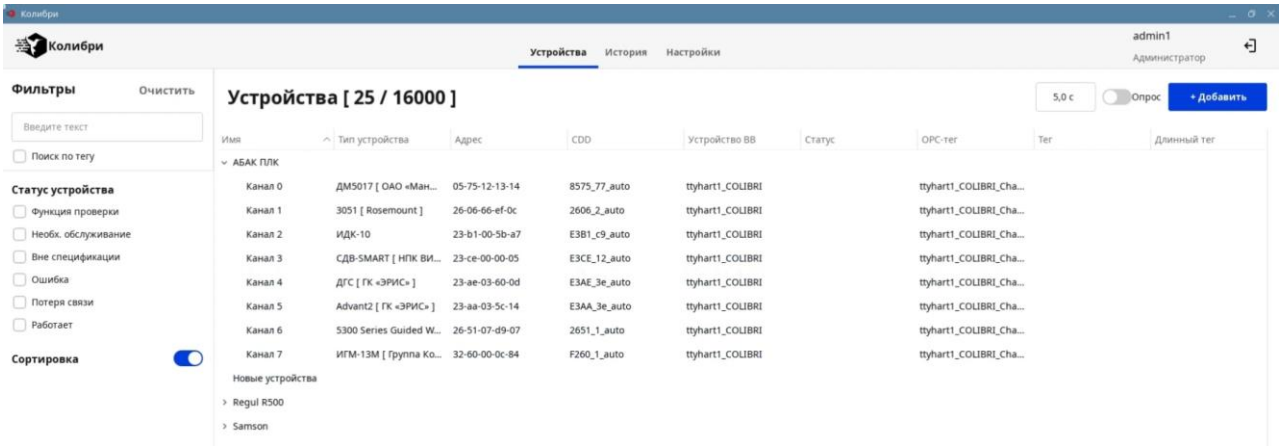

Fig. 2. Enterprise structure

However, the number of field devices at a real facility may reach thousands or even tens of thousands; therefore, it is crucial to conduct load testing of the proposed dynamic structure. To address this need, a Virtual Emulator for HART / Colibri field devices has been developed based on a server cluster with HART-IP support.

Experiment

To verify the performance and stability of the host monitoring and diagnostics system for field devices supporting HART / Colibri protocols under heavy load conditions (diagnostics of 4096 field devices) without using real instrumentation, a virtual emulator was developed. This emulator supports configurable imitation of response delays from field devices.

Virtual field devices support universal commands of HART / Colibri protocols and are grouped (up to 64 devices per group) to simulate a PLC input-output module or HART multiplexer. For virtual field devices, users can set the extended device type and software version, while the polling address and unique device address are generated automatically.

To simultaneously process requests from the host system, each emulated module functions as an independent server with HART-IP, which the host system connects to. To simulate a large number of modules, a software application with a GUI, called Virtual Unit, was developed for configuring the emulated modules and managing the server cluster (start and stop operations). The server cluster fully utilizes all CPU cores of the computer, enabling testing of the host system with simultaneous connections to a large number of field devices using a single Linux-based computer.

Using this emulator, it was possible to simulate 8192 devices and verify software stability under this load. Stress test included continuous software operation for three days. During the test, Colibri software worked without any failures. Currently, it is planned to increase the number of simulated devices to sixteen thousand to verify software reliability.

Conclusion

Colibri software is field device monitoring and diagnostics system, that supports dynamic generation of universal GUI based on interpreting Colibri Device Descriptions (CDDs). This technology allows automatic adaptation of interfaces for any intelligent sensor or field device, making configuration and management processes quicker and easier.

A customizable representation of enterprise structures has been developed, allowing for convenient visualization, grouping, sorting, and editing of large numbers of field devices.

To evaluate Colibri software performance under realistic heavy-load scenarios, a specialized virtual emulator based on a server cluster with HART-IP support was created. This emulator can simulate response delays and handle simultaneous connections of thousands of virtual field devices, which allows to conduct stress testing without the need for connecting physical hardware.

Stability tests demonstrated that Colibri software could reliably manage simultaneous interactions with up to 8,192 virtual field devices for an extended period (three consecutive days), without failures or performance degradation. Ongoing development aims to further validate scalability by expanding simulation capacity to 16,000 devices.

References

1. ПШПД Колибри // ООО "Аспект": Разработка цифровых измерительных систем. – URL: https://digitalmetrolog.com/ru/colibri (accessed: 20.02.2025).

2. ОТЗ-06.01.15.2024 Полевая шина передачи данных Колибри // ИНТИ. – URL: https://inti.expert/docs/industrial%20automation/otz-06-01-15-2024/ (accessed: 20.02.2025).

3. Документы о совместимости // ООО "Аспект": Разработка цифровых измерительных систем. – URL: https://digitalmetrolog.com/documents (accessed: 20.02.2025).

4. Qt Documentation | Home // Qt Documentation. – URL: https://doc.qt.io/ (accessed: 10.03.2025).