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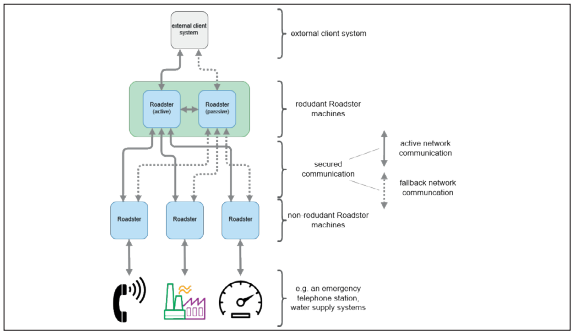
Extending a SCADA framework to support high availability

Increasing the safety and security of systems supervising industrial equipment in tunnels, traffic systems, and water supply systems

This emergency telephone station is one of various field devices supported by Roadster

The technologies used during this bachelor thesis



Roadster multi-layer topology setup including industrial equipment

Introduction: Roadster is mindclue GmbH's in-house framework to build modern supervision and control applications found in various technical fields including traffic systems, energy, and water supply. Event-driven in nature, it is written in Ruby and uses ØMQ to pass messages within a system of loosely coupled actor processes following a shared-nothing architecture. State changes are replicated using messages. A web UI and sophisticated alarm case management are part of a normal Roadster application. The following goals were pursued as part of this project: to increase the flexibility of Roadster installations, and the framework needed to be extended with the capabilities to run on multiple autonomous machines. Furthermore, to provide a highly available service, and pairs of identical machines needed to be able to operate in a redundant setup. This ensures a continuous service delivery in case one of the machines fails. The communication between such machines needed to be secured through the use of encryption. Interoperability with client systems interacting with such a redundant setup also needed to be guaranteed.

Approach/Technologies: The students gathered exact requirements, developed solutions fitting Roadster's software architecture, including prototypes, new communication protocols and required components. All contributions have been made following software engineering methodology and applying best practices. Modern cryptography software is used to encrypt network traffic as well as verify the authenticity of messages passed between machines. New and a significant amount of existing functionality has been verified using comprehensive test suites ranging from unit tests to system tests encompassing virtual networks of fully isolated Roadster machines. Behavior-driven testing frameworks and technologies such as GitLab CI, Mininet, and Docker have been leveraged for continuous integration and quality assurance.

Result: Groups of Roadster machines (including the aforementioned high-availability clusters) can now be configured using a domain-specific language. State is replicated across machines through secure network communication. Redundant machines operate in an active/passive setup while ensuring interoperability with external client systems. Utilities to simplify the bootstrapping process of a new Roadster machine (key generation and distribution) are provided and documented. All steps taken to reach the final result are documented comprehensively.