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Improving energy community interoperability: a Web of Things approach

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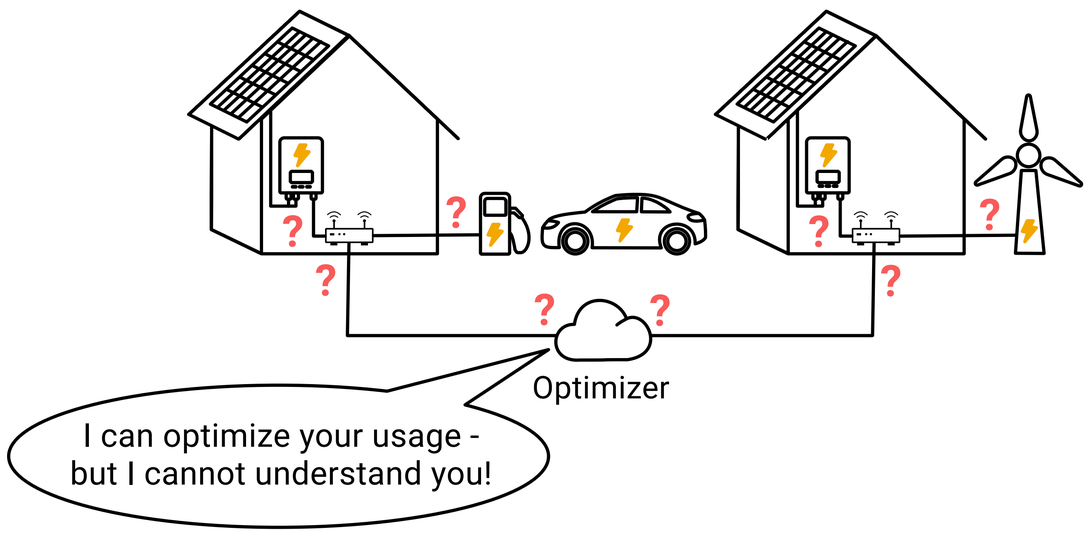
1. Problem

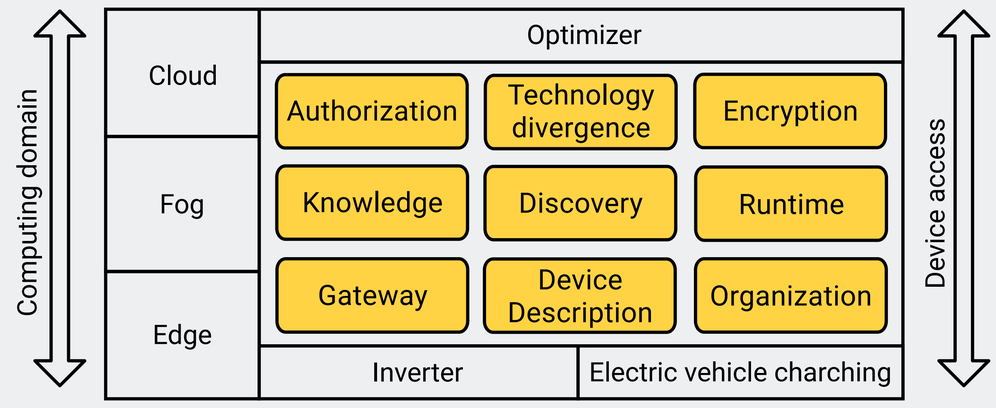
Sensor data is key for optimizing energy usage in energy communities. Unfortunately, the use of different communication technologies led to a **diverse landscape of incompatible devices**. Problems in this context are:

- Incompatible protocols
- Complicated integration processes
- Disclosed traffic
- Varying security mechanisms
- Different encodings



2. Research

The question is, what is a suitable way to facilitate interoperability and integration problems with minimal disruptive measures. This intention was achieved by constructing a **service-oriented Web of Things** architecture. The process followed the **design science research** process by Peffers et al. and started with the identification of nine key aspects that are visualized in the following figure:



3. Architecture Design

The architectural approach handled the key aspects by **outsourcing concerns to five separate services:**

The **Directory Service** maintains and provides device descriptions for device and service orchestration.

The **Runtime Service** dynamically instantiates gateway scripts to transform traffic and translate data.

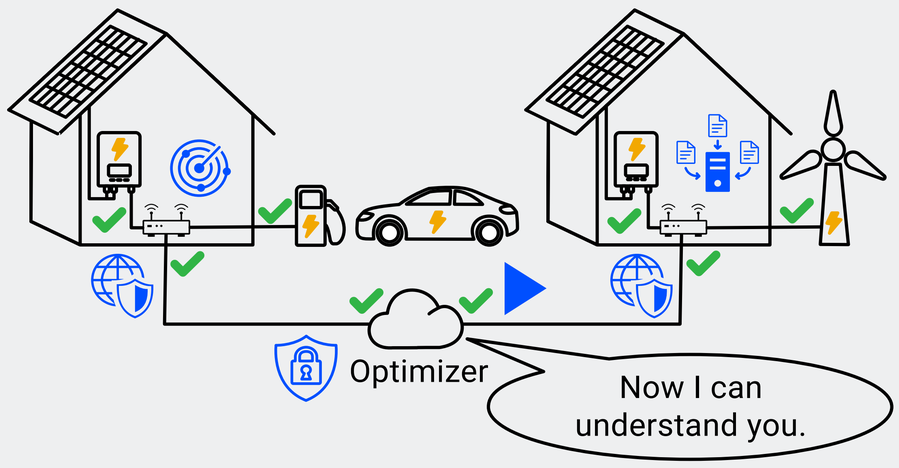
The **Network Service** provides a common (virtualized) network for devices and services.

The **Security Service** manages device and service access and authorization.

The **Discovery Service** identifies devices via diverse adoption and scanning methods.

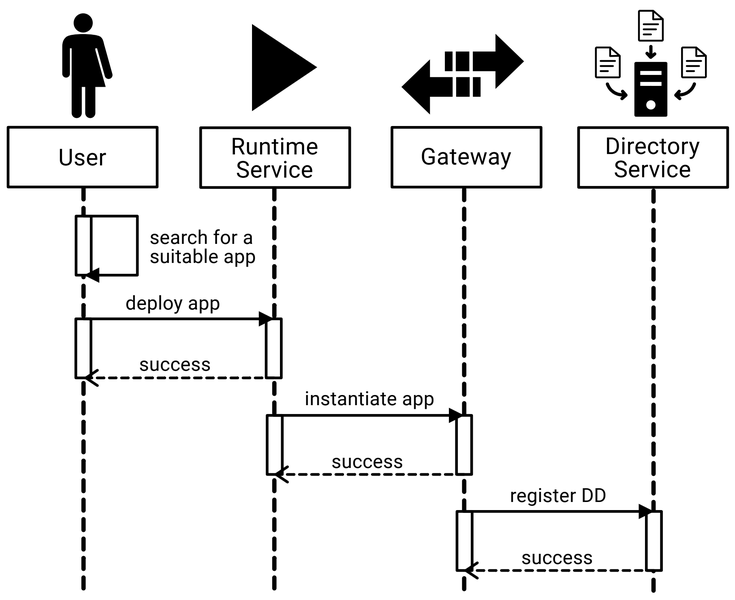
4. Solution

A corresponding service architecture can now solve interoperability. For example, the Directory Service can be deployed in a building to maintain a list of local devices. Similarly, the Security Service can be deployed in the cloud for central authorization management. An exemplified deployment could look like this:



5. Service Interaction

Interaction of the services with corresponding users and devices was specified using sequence diagrams. The following diagram shows an exemplified instantiation procedure of a gateway that translates protocol messages:



6. Implementation & Results

A simulation tested the architecture's feasibility by utilizing the **Web of Things** standard, **HTTP,** and **JWT**. Interoperability was tested by adopting a compatible electric vehicle charging station and a legacy inverter. The solution was evaluated by verifying the predefined architectural properties **confidentiality and access control, interoperability, usability, and extensibility**. As a result, the experiment showed that a service-oriented and Web of Things-based solution **is suitable** to facilitate interoperability and integration problems in energy communities.