Extending the re:mote system for water quality measurements and turtle tracking using mobile devices and Bluetooth-enabled sensors

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Low-cost Water Quality Sensing and Turtle Tracking

The goal is to develop with project partners software and hardware infrastructure for long-term monitoring of water quality parameters and seasonal monitoring of turtle movements.

Motes (Sensor Devices, IoT Devices):

- Software correctness is a must
- Unreliable communication, changing network topology, long distances
- Limited power supply: low frequency processors, low power modes
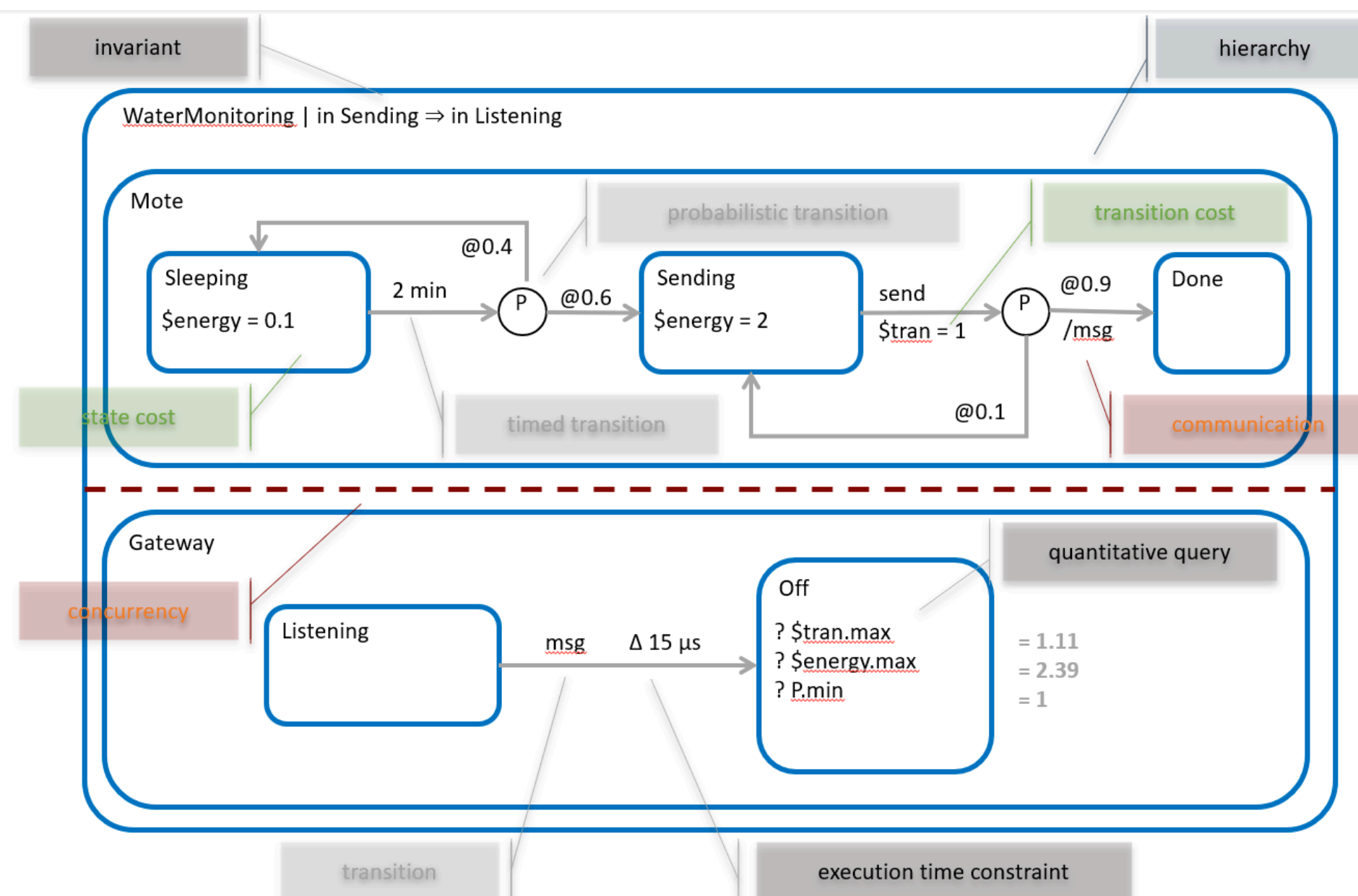
Server:

- Large amounts of simply-structured data
- Erroneous data with "real" anomalies
- Visualization and further programmatic analysis

Low-cost hardware and open-source software are preferred. All contributions are open-source.

Model-Driven Development

pState: A holistic approach for embedded system development

- Correctness, reliability, power consumption, execution time, ... deduced from formal model of motes + environment, taking unreliability into account
- Code guaranteeing analyzed properties automatically generated
- web-based, "literate" user interface
- backend with probabilistic model checker, SMT (satisfiability modulo theories) solver

Arduino-based motes

The network consists of Arduino-based motes:

- **Gateway** to relay end-node data to the server over the internet using a 3G connection.
- **End nodes** to measure water quality parameters through connected sensors.
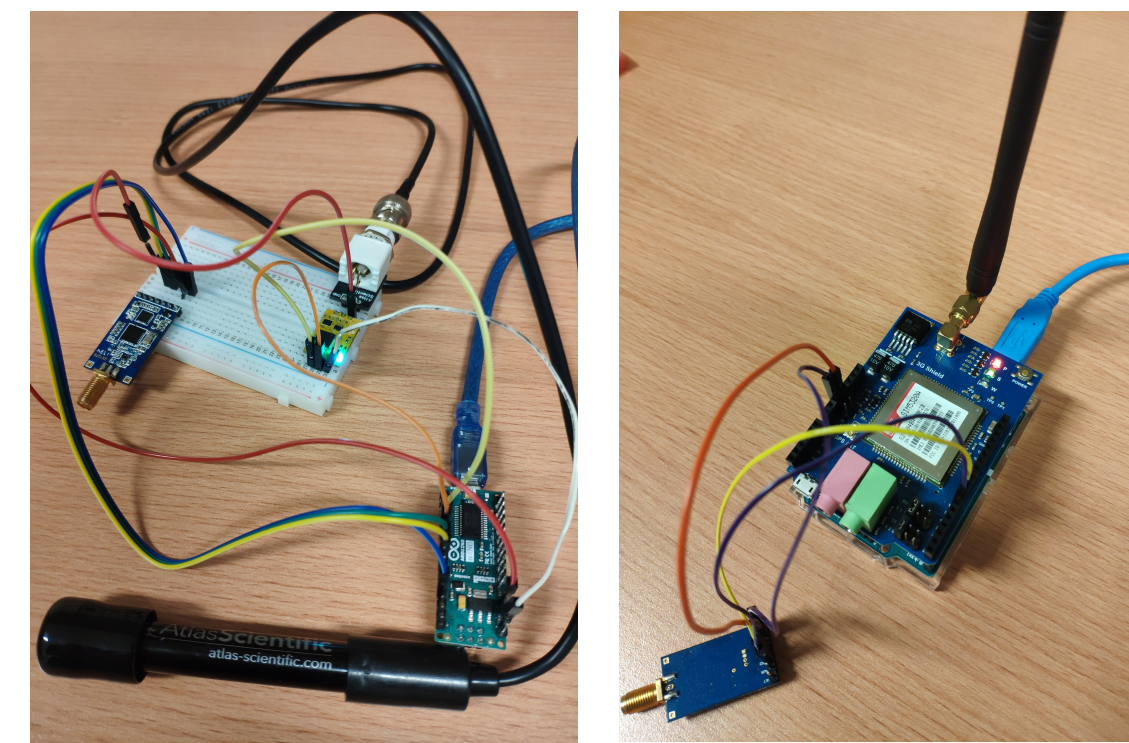

Low-power Long-range Sensor Network

A LoRa mesh network is used for connecting motes.

- It is a low-bandwidth, low-power and long-range network.
- The mesh network is tolerant to faults, changing network topology, extension and contraction.
- Initially, the sensors used are commercial off-the-shelf sensors for dissolved oxygen, pH, electrical conductivity, temperature, etc.
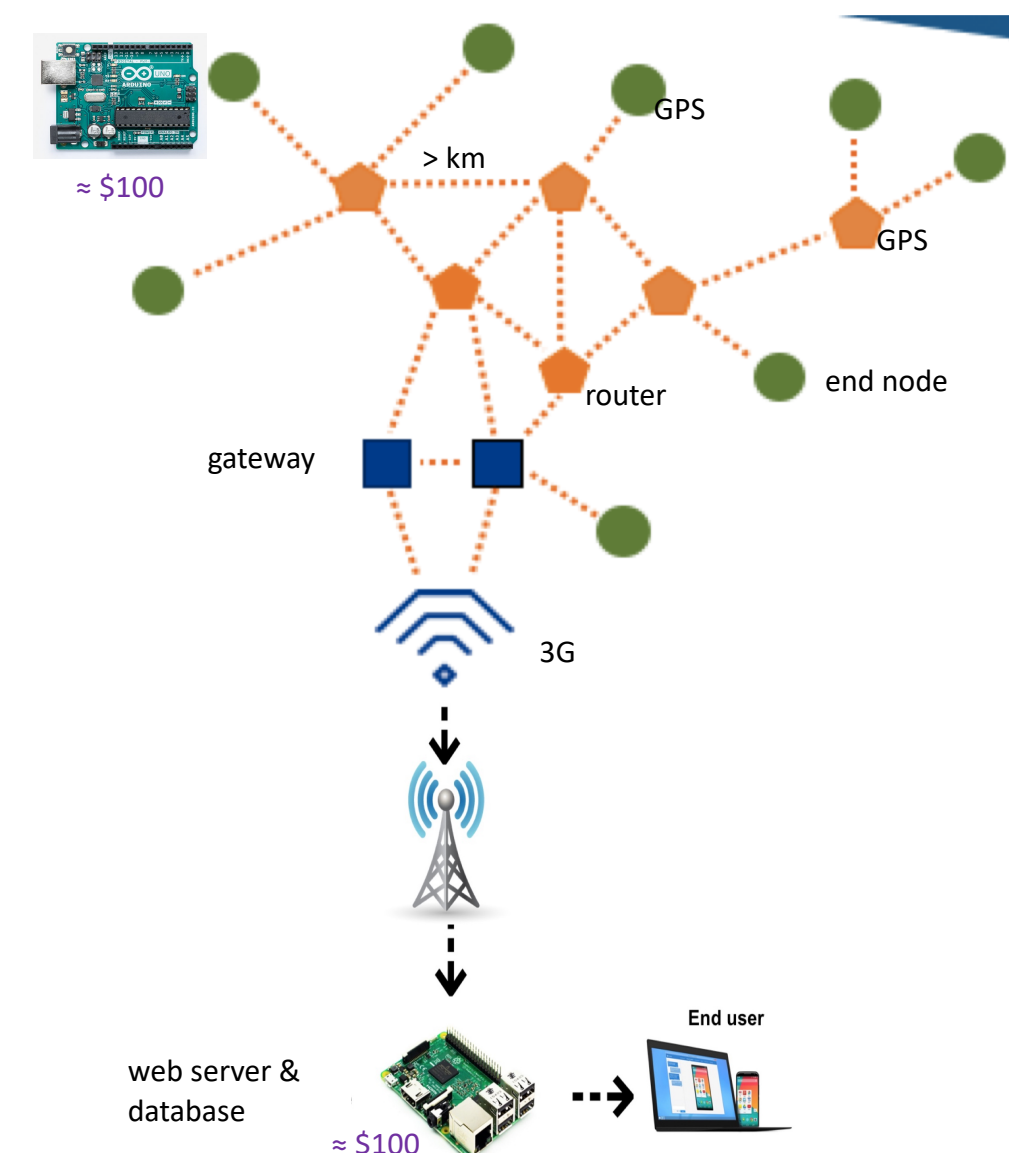
Raspberry Pi Server

- A server programmed in Go for fast and concurrent connections.
- A progressive web application designed in React with a custom API.
- A time-series database (InfluxDB) for simple data storage and a smaller footprint. Time series databases assume insertions are more frequent than queries, so it allows for the fast insertion of large amounts of data such as water quality data.
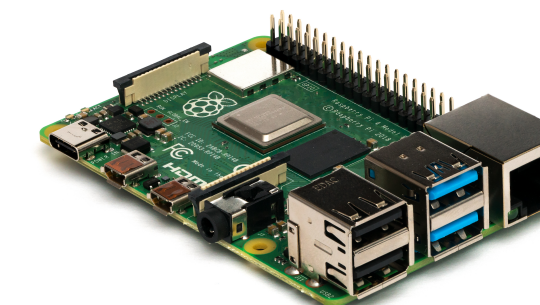
Extending the re:mote system

1 The progressive web application can be accessed via any Web Bluetooth-enabled browser on a mobile device.

2 Measurement tools can be assembled using low-power sensors and a Bluetooth-enabled Arduino. The Arduino is flashed with custom software to be recognized by the progressive web app.

3 Measurement can be taken once connected over Bluetooth and stored locally via the Web Storage API. After data collection is complete, it can be exported or saved to the server as data points.

Multilingual Mobile App

Multilingual user interface implemented through Progressive Web App

- Common development stack between web and mobile
- Defining offline behaviour through background service workers