SwissQM: Next-generation Data Processing in Sensor Networks

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Data Processing in Sensor Networks

- Sensor networks
  - The dirty way: NesC, TinyOS, etc.
  - The refined way: queries (TinyDB/Cougar like)

- Unfortunately not enough
  - “Murphy loves potatoes”
  - Much infrastructure needed (cleaning, adaptation, filters, models, …)

- We needed something better
Requirements

- We want a system that is
  - Language independent (SQL, XQuery, Java, new languages, Webservices …)
  - Turing complete
  - User-defined functions
  - Capable of pushing down complex processing functions all the way to the sensors

- Solution: Virtual Machine tailored to data acquisition in sensor networks.
SwissQM: Scalable Wireless Sensor Query Machine
SwissQM on the Sensor Node

- Stack-based VM
- Integer Arithmetic only
- 59 bytecode instructions
  - 40 = JVM
  - 19 = sensor network specific
- Transmission Buffer
- Synopsis
- Multi-tasking
- Two platforms

Synopsis

Stack-based VM

Integer Arithmetic only

59 bytecode instructions

40 = JVM

19 = sensor network specific

Transmission Buffer

Synopsis

Multi-tasking

Two platforms

Bytecode Interpreter

Radio

Transmission Buffer

Operand Stack

Sensors

Running

deployed QM Programs

Synopsis
SwissQM + Gateway System

TinyDB

SQL
Translation
Virtual Query

XQuery
Translation
Virtual Query

Web Service

Java
Translation
Virtual Query

Your language here

Compiler/ Optimiser

SwissQM Programs

QM Prog₁ ...
QM Progm
Why SwissQM?

- Event-processing at the sensor nodes
- Implement data-cleaning pipelines
- Finite state automata at the sensors
- Compact bytecode
- Systems with a high turnaround

```java
int ewma(int u, int alpha) {
    static int yold = 0;
    int y;
    y = (yold*alpha + (10-alpha)*u))/10;
    yold = y;
    return y;
}
```

- EWMA Filter
  ```sql
  SELECT nodeid, ewma(light, 2)
  FROM sensors
  SAMPLE PERIOD 4s
  ```
Conclusions and Outlook

- SwissQM: flexible programming platform for data acquisition tasks in sensors networks
- SwissQM is the means to an end (automatic adaptation, optimisation, complex algorithms,…)
- Increases abstraction level at the network interface
- Powerful instruction set → short programs → eases dissemination
- Future Sensors?
  - May have more memory and CPU power
  - But radio bandwidth and reliability still an issue
  - Cost-efficiency
Try it yourself

Download SwissQM at
http://swissqm.inf.ethz.ch

SwissQM