SwissQM: Next-generation Data Processing in Sensor Networks

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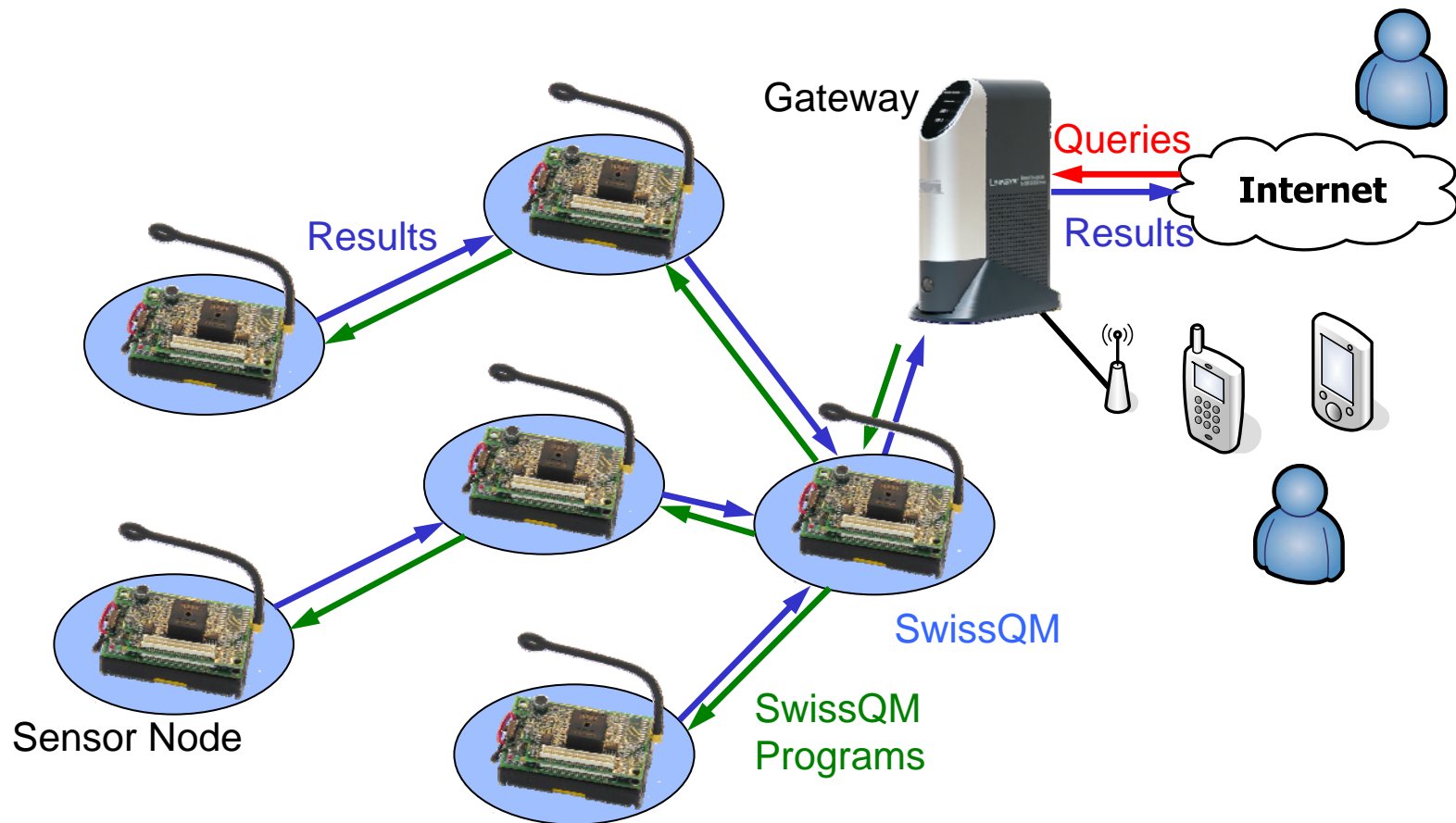
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Data Processing in Sensor Networks

- **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, …)
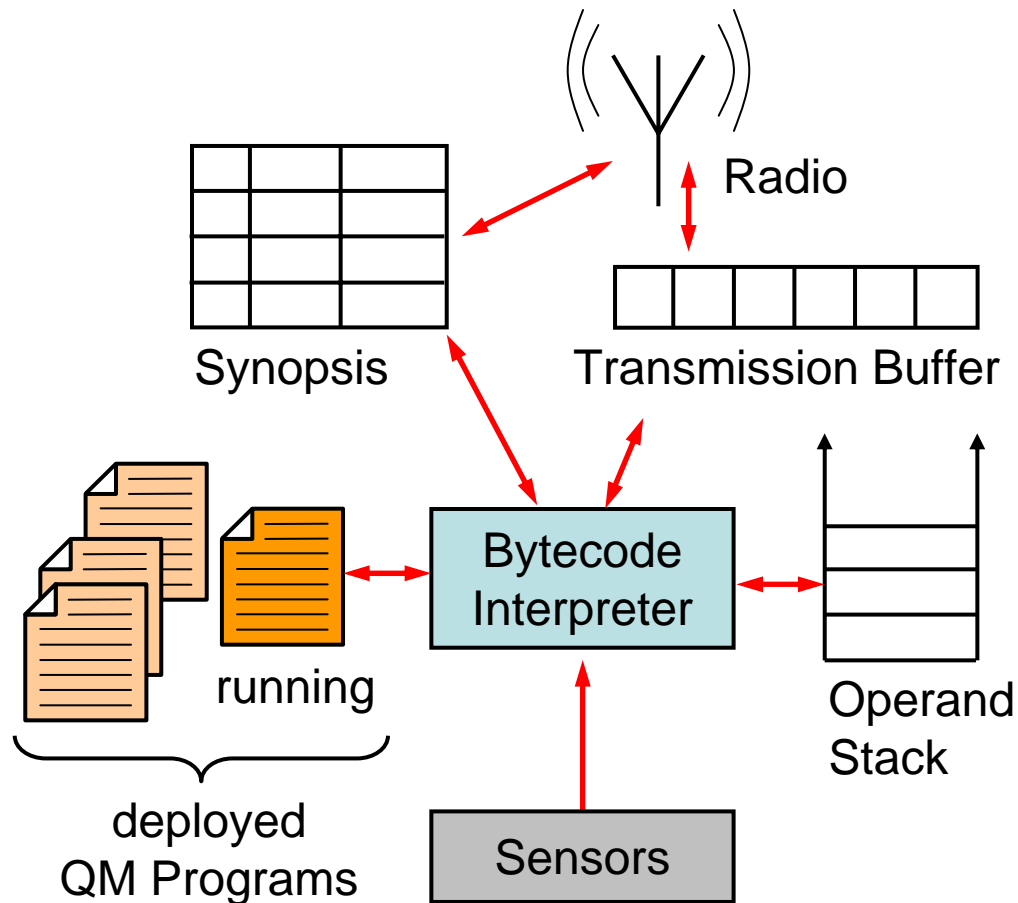
- **We needed something better**

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.
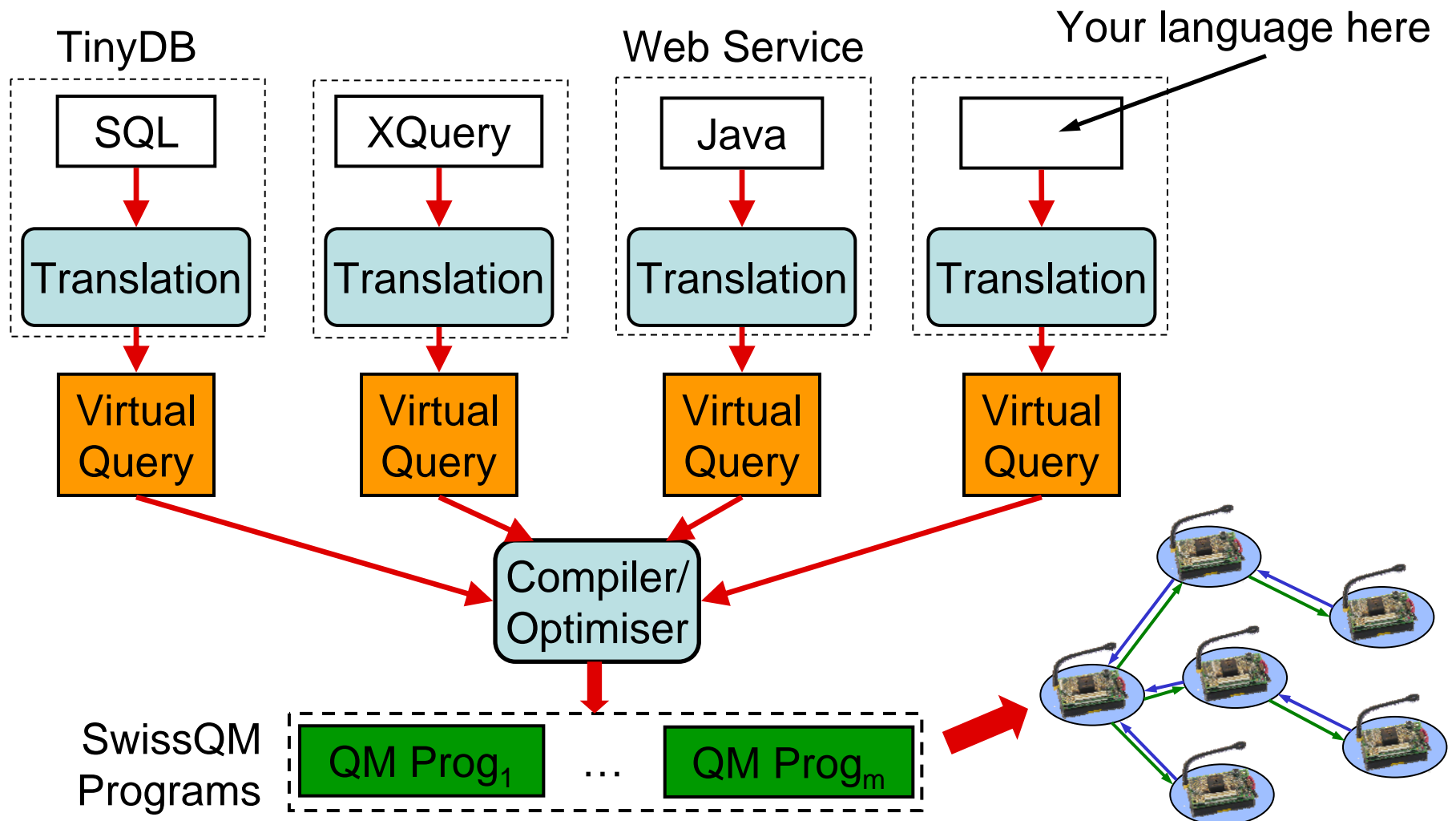
SwissQM:
Scalable WIreleS Sensor Query Machine

SwissQM on the Sensor Node

Radio

Synopsis

Transmission Buffer

Bytecode Interpreter

running

Operand Stack

deployed QM Programs

Sensors

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

SwissQM + Gateway System

TinyDB

Web Service

Your language here

SQL	XQuery	Java	
Translation	Translation	Translation	Translation

Virtual Query — Virtual Query — Virtual Query — Virtual Query

Compiler/ Optimiser

SwissQM Programs

QM Prog$_1$ … QM Prog$_m$

Why SwissQM?

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

- Event-processing at the sensor nodes

- Implement data-cleaning pipelines

- Finite state automata at the sensors

- Compact bytecode

- Systems with a high turnaround

- EWMA Filter

```
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