Master Practical Course: Edge Computing and the Internet of Things

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Original material/concept by Teemu Kärkkäinen
Why are we here?

Learning by doing:

You can pass exams without ever learning anything; you cannot **design and build** a system without learning.
Idea: *Emulate a product/service development project.*

*From an idea to a documented prototype.*

*Using a variety of devices and technologies.*
Why are we here?

Key elements:

Team

*People to work and learn with.*

Equipment

*Real devices to build with.*

Goal

*Clear goal and a structured path towards it.*

Time

*Full semester, lots of credits.*
Course Structure

- **Bootup**
  - Developing a project idea.
  - Implementation sprints.
  - Progress meetings: Every other Friday

- **Lectures**
  - Topic selection
  - Gear handout

- **Implementation**
  - Demo Day 02.02
Rough Schedule

10 ECTS / 60 days = 10 ECTS * 25 h/ECTS / 60 days
= ~4 h/working day

Lectures
Monday 16:00–18:00, Room 01.07.023
Covers technologies and approaches needed for successful projects.
Strong SHOULD attend (email the lecturer if you will miss a lecture).

Practical Sessions
Every other Friday 13:00–17:00, Room 01.07.023
Progress update for all teams + discussion.

Implementation
Continuously updating repository
Intensive development effort will fail without *structure*, but we’re not here to run a *bureaucracy*.

**Scrum-ish** project management:

**Backlog:**
- Tasks go into the backlog (issue tracker).
- Work is done from the backlog.
- The backlog is changed, ranked and tracked.
  
  *Visible to the course staff.*

**Bi-weekly presentations:**
- What was done, what will be done, any problems.
We provide a list of equipment available.  
*Range of consumer devices available today.*

Each team will choose their needed equipment.  
*Based on the project.*

We will provide sets of equipment to the teams.  
*Within reason and availability.*

Teams are responsible for the equipment.  
*You sign for it and return it after the course.*
### Equipment (selection)

#### Computing
- Raspberry Pi 3/4
- Raspberry Pi Zero W
- ESP32 microcontroller
- ESP32 + LoRa
- Android phones
- Mini-PCs
- NVIDIA Jetson

#### Communication etc.
- RFID reader + bacon/card
- GPS receiver
- Software defined radio receiver
- 433 MHz simple link kit

#### Components
- Breadboards
- Connectors
- Passive electronics
- Active electronics

#### Sensors + Actuators
- PIR motion sensor
- Ultrasonic distance sensor
- Temperature sensor
- Temperature + humidity sensor
- Volatile gas sensor
- Sound sensor
- Buzzer (active/passive) module
- Capacitive touch sensor
- LCD character display
- Relay switch
- Force sensing resistor
- Infrared line tracker
- Triple axis accelerometer + gyro
- Capacitive touch switch
- Raspberry Pi camera
- Servo motor
- Stepper motor
- RGB LED module
- RG LED module
- Auto flash LED module
- I2S microphone

#### Additional Modules
- Laser module
- Button module
- Tilt-switch module
- Mercury switch module
- IR receiver module
- Reed switch module
- Photo interrupter module
- Rain detector module
- Joystick module
- Hall switch module
- Analog temperature module
- Thermistor module
- Sound sensor module
- Photoresistor module
- Flame sensor module
- IR remote controller
- Rotary encoder module
- IR distance module
- Pressure sensor module
- Real-time clock module
- Speakers
- Shelly Plug
Basic electronics workstation
   Soldering, lab power supply, oscilloscope, etc.

Basic 3D printing
   Prusa i3 MK3, Bambu Lab X1C, basic filaments

Limited resources
   If you need them, email us for an appointment
What to do with the equipment?

Each individual piece has limited usefulness, but the pieces become valuable as a networked system.

Big providers build centralized systems to which every device connects, but we want to build the system ourselves by having the devices communicate directly.

This is an advanced course; we expect you have learned a lot already. This is a chance to put it into action and fill the gaps. **Challenge yourself**, try something new and challenging.

(i.e., don’t just run PHP+MySQL on a PC and connect to it with a phone’s web browser, don’t just connect everything to a cloud service, etc.)
Combination of a team and an individual grade.

The **process** is evaluated (25%).
- Idea creation, implementation, presentations.

The **end result** is evaluated (50%).
- Product (demo), documentation, quantitative evaluation.

**Individual** contributions are evaluated (25%).
- Peer evaluation, practical meetings, repository activity, lecture attendance and contributions.
Goals:

• Experiment with common IoT equipment
• Experiment with the required tooling and CI systems
• Broaden your horizons and explore new ideas

Exercises (more details on the exercise sheet):
Blink an LED, read sensor values, build a distributed application spanning multiple edge devices, set up a CI pipeline, update your application over the network

Optional; recommended if you don’t have prior experience
Questions?

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