Software Engineering of Internet of Things

Toolchain Handin: Full-Circle Latency

Aslak Johansen <asjo@mmmi.sdu.dk>

February 18, 2020

1 Context

Delays caused by programs, the underlying support system (e.g., operating system or framework) and peripherals follow different patterns on your laptop and your IoT device.

2 Exercise

Create a loop where a laptop triggers code execution on an IoT device which triggers code execution on another IoT device which triggers code execution on the laptop, and do as precise measurements as possible of the time it takes from laptop transmission to laptop reception.

3 Recipe

1. Locate your documentation.
2. Write a signal generator that sends out a clock signal (i.e., 1-0-1-0-1-0) over a serial connection at a fixed rate.
   - Use an appropriate language.
   - Log the value and the timestamp (of ns accuracy) just before and just after transmitting the value.
   - To be executed on the laptop.
3. Write a command and control program that turns on an LED when it received a message with a 1 payload and turns it off when it receives a 0 payload.
   - To be executed on the first IoT device.

4. Write a program that constantly samples the light sensor and every time the measured value changes it emits a 1 (if there is light) or a 0 (if there is no light) on the serial line.
    - Experiment to find a proper threshold for defining whether there is light.
    - If your light sensor is slow, how can you improve the speed?
    - To be executed on the second IoT device.
5. Write a program that logs every message received over a serial line along with a timestamp (of ns accuracy).
    - Use an appropriate language.
    - To be executed on the laptop.
6. Perform an experiment where the signal generator communicated over a USB cable with the command and control program, which communicated optically with the light level sampling program, which communicates over another USB cable with the message logging program.
    - For each command being issued, calculate the end-to-end latency.
    - Run the whole thing for a couple of hours to get a large amount of samples for analysis.
7. Plot all the measured latencies four times as histograms with bucket sizes of 100us, 1ms, 10ms and 100ms.
    - Choose proper units for axes.
    - Use proper labeling of axes.
8. Explain what you see.

4 Requirements

1. Describe the experimental setup.
2. Answer the following questions:
    (a) How would you expect the distribution of the latency through the whole system to look like?
    (b) What is the distribution of the latency through the whole system?
    (c) Explain any deviation?
3. Hand in as a group by sending a mini-report as PDF to asjo@mmmi.sdu.dk with subject
`"SDU IoT 2020: Handin 1 - Full-Circle Latency"`
4. Deadline: March 4, 2020