# About Things

## ELEC-E9900 Networked Partnering and Product Innovation - NEPPI

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21.11.2022

# Recording

# Learning Goals

1. Learn to use reference designs to guide your design concept vision

# What is a reference design?

- Reference design is a product that has as similar properties / functionalities with your intended product as possible

# What are the things to check?

- Claims / arguments / selling points
- Functionalities
- Size, shape, materials
- MCU
- Battery
- Sensors, actuators
- Price

# Example product

# How to update your design concept

# IoT Product Concept Document

1. Concept description
   a. Name, purpose
   b. Key design requirements
      i. Design Driver(s)
   c. Possible system architecture
      i. Cloud
      ii. App
      iii. Network
      iv. Thing
2. Partnering
   a. Your own role (or envisioned role for a start-up)
   b. Expected roles for partners
   c. (Possible real partners to consider)
3. Estimated production cost per physical product unit (Thing)
   a. Total desired volume, year 1
4. Estimated key running costs
   a. Personnel, storage, web services, data plans, …
5. Key sources of revenue
   a. Getting started – investors
   b. Sustained revenue – customers

# Computational capabilities

- Read a sensor and drive a servo - Arduino UNO
- Display messages on small OLED screen - ESP32
- Do real-time audio processing - ESP32 (limited)
- Artificial Intelligence and Machine Learning - ESP32 (limited)

# Typical electronic elements of an IoT product

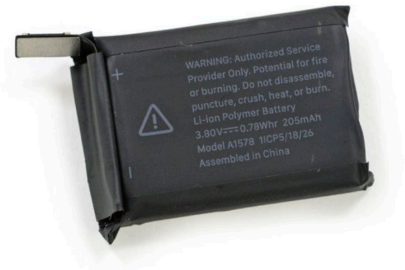
- Battery (+battery management and charging)
- MCU (micro-controller unit)
- Sensor(s)
- Actuator(s)
- PCB / wiring / components

# How big a battery do we need?

- https://www.apple.com/watch/battery/
- 542 mAh battery

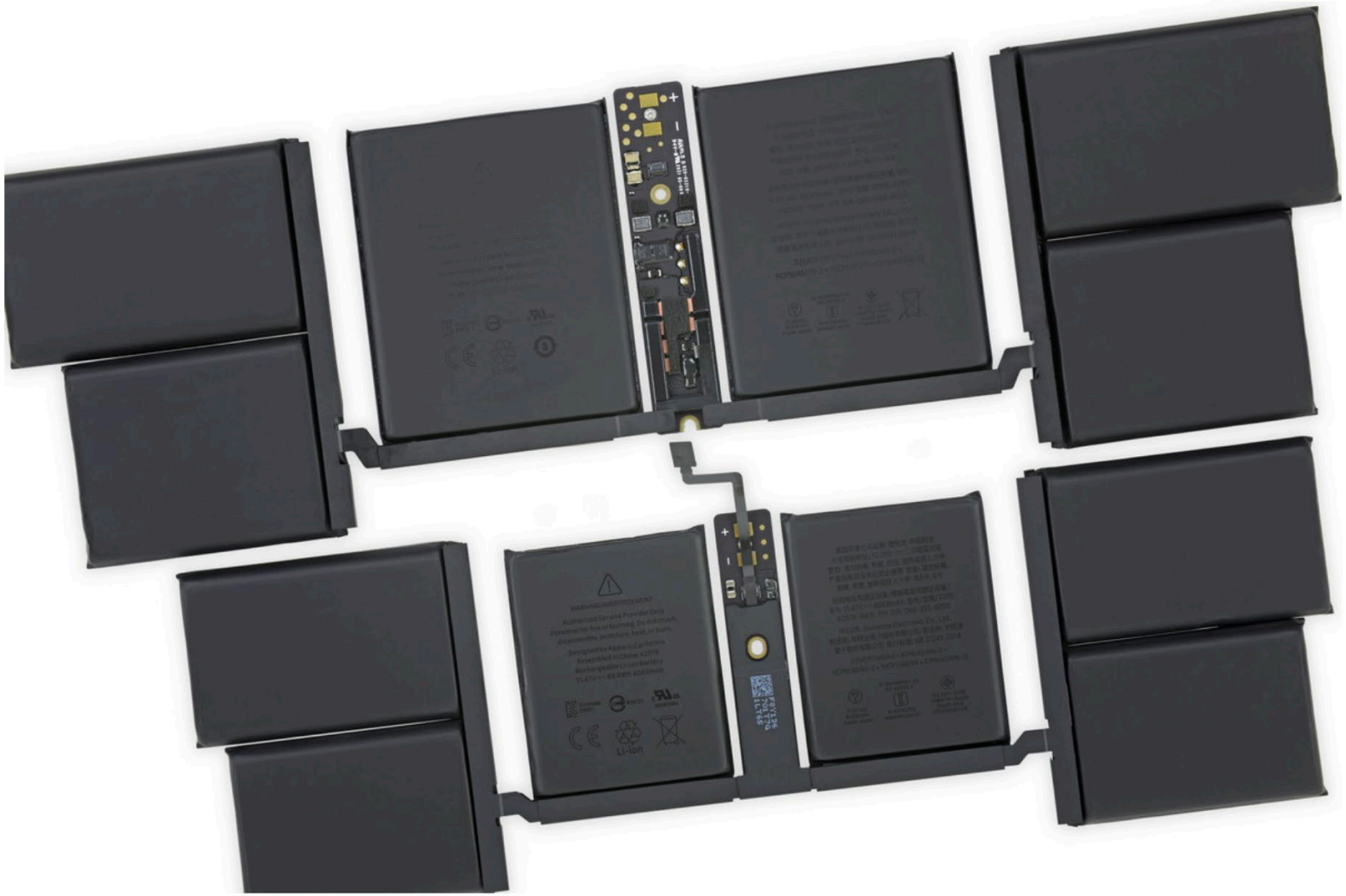
# Batteries Reference Prices

- Ring-size curved, 20 mAh, ~10 €
- Wristband-size 50-70 mAh, ~3 €
- Watch-size 200-500 mAh, ~7 €
- Palm-size 1.4 Ah, ~7€
- Book-size 8 Ah, ~50 - 100? €




2021 MacBook Pro has 12 battery modules…

# 2021 16-inch MacBook Pro, 99.6 Wh battery (11.45 V, 8693 mAh)



Batteries from the 16” (top) and 14” (bottom) 2021 MacBook Pros. Click to enlarge

iFixit

# MCU comparison table

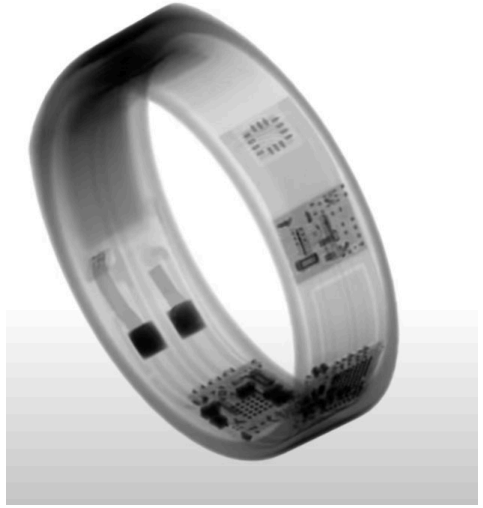
- ATMega328 (Arduino UNO) ~2€
  - Speed 20 MHz, single core, 8 bit
  - Program Memory 32 KB, Data memory 1 KB

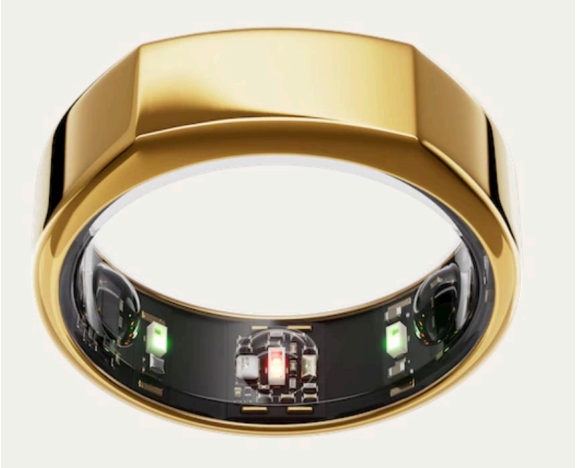
- ESP32 ~3€
  - Speed 240 MHz, dual-core, 32-bit
  - Program memory 520 KB, ROM 448 KB, Flash 16 MB

# Meaningful differences in MCUs

- Processing capacity
- Memory
- Connectivity
- Inputs/Outputs
- Buses / Protocol support

# Ring-size - Oura





- https://ouraring.com/

- Weight: 4 to 6 grams
- Width: 7.9mm
- Thickness: 2.55mm

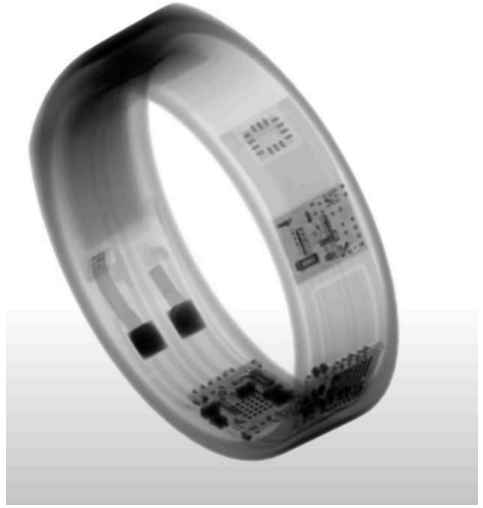
**Sensors**:

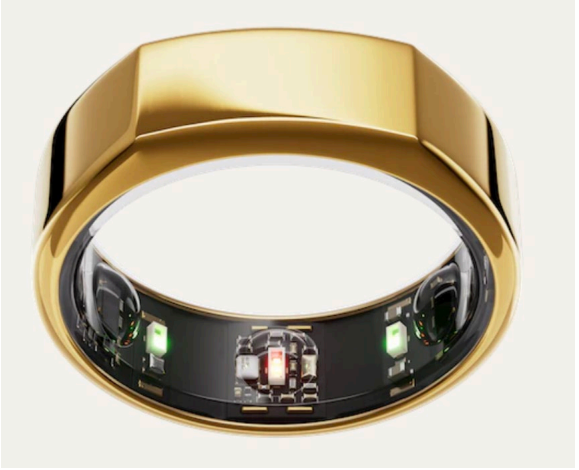
- Green LEDs (optical heart rate sensor)
- Red LED (blood oxygen sensor)
- Infrared Photoplethysmography (PPG) sensors
- Skin temperature sensors (negative temperature coefficient sensors)
- Photodiodes
- 3D Accelerometer

**Connectivity**:
Bluetooth Low-Energy (Bluetooth Smart®)

**Battery & Power:**
Up to 7 days of battery life

# Ring-size - Oura





- https://ouraring.com/

**Battery: Grepow curved LiPo ~10€**
21mAh, 0.0777Wh

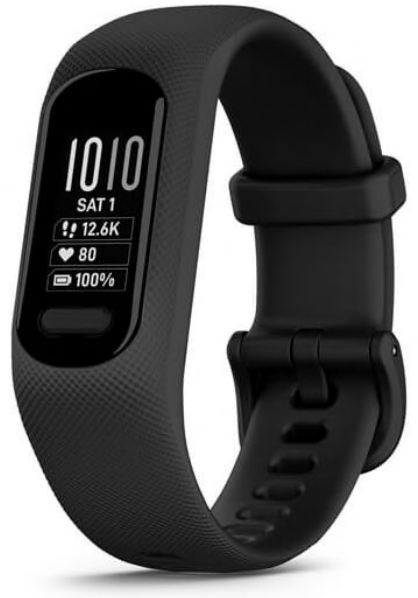
**MCU: ~10€**
Infineon PSoC 6 MCU: CY8C63x6
32-bit Dual CPU Subsystem
- 150-MHz Arm® Cortex®-M4F
- 100-MHz Cortex-M0+

**Battery management: ~€1**
Texas Instruments BQ25155

**Titanium ring: ~?€**

**Sensors: ~2€**
**LEDs**: ~0.2€
**Other components**: ~5€

# Wrist band –size Garmin Vívosmart 4




- https://www.garmin.com/en-US/p/782585#specs

- MCU: nRF51422, ~2€
- Capacitive touch: CY8C20247S, ~1€
- Battery: 70mAh, Li-Ion, ~3,5€
- Battery management: ~3€

**Connectivity**:
Bluetooth Smart®, ANT+®

**Battery & Power:**
Up to 7 days of battery life

Sensors

| | |
|---|---|
| GARMIN ELEVATE™ WRIST HEART RATE MONITOR | ✔ |
| ACCELEROMETER | ✔ |
| AMBIENT LIGHT SENSOR | ✔ |
| PULSE OX BLOOD OXYGEN SATURATION MONITOR | ✔ |

# No batteries at all?

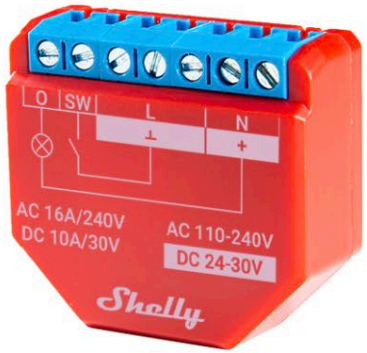
**Shelly 1PM**


| CPU | RAM | Antenna | Overvoltage protection | Overpower protection |
|---|---|---|---|---|
| ESP8266 | 2MB | Flexible PCB | No | YES |
| **Overtemp. ptotection** | **DC** | **AC** | **Bluetooth** | **Cloud + MQTT** |
| YES | 24-60V | 110-240V | No | Separately |
| **MQTT + SSL** | **UDP** | **Webhooks** | **User reset button** | **№ of parallel connections** |
| No | Yes | HTTP | YES | 2 |
| **Webhook limit per action** | **Scheduled webhooks** | **Scripting on device** | **Sunrise / Sunset actions** | **WiFi AP and Client mode** |
| 5 | No | No | +/- 6h | Separately |

| CPU | RAM | Antenna | Overvoltage protection | Overpower protection |
|---|---|---|---|---|
| ESP32 | 4MB | Embeded Long distance | YES | YES |
| **Overtemp. ptotection** | **DC** | **AC** | **Bluetooth** | **Cloud + MQTT** |
| YES | 24 - 30V | 110 - 240V | YES | Simultaneously |
| **MQTT + SSL** | **UDP** | **Webhooks** | **User reset button** | **№ of parallel connections** |
| YES | RPC | HTTP & HTTPS | YES | 10 |
| **Webhook limit per action** | **Scheduled webhooks** | **Scripting on device** | **Sunrise / Sunset actions** | **WiFi AP and Client mode** |
| 20 | YES | YES | +/- 23h | Simultaneously |

https://www.shelly.cloud/shelly-plus-1pm/

**Shelly Plus 1PM**




Aalto University

IDBM International Design Business Management

# Product elements

- Physical parts

- Electronic parts

# Challenge – Prototype vs. Concept

- Design Concept represents the desirable future vision
  - It is a management tool
- Prototype represents what you want to learn
  - It is a learning tool
- Reference designs are good place to learn!

# NEXPO22

- Product Concept / clarity/perceived value/attractiveness
- IoT Service / illustration of system architecture
- Physical Product / illustration/physical mock-up
- Product UX / demo/video
- Stand Experience / presentation/attractiveness/feel

- Evaluated collaboratively with NEXPO visitors + You & Me

# Deliverables

- Weekly deliverables
  - W1: IoT Machine – Challenge 1
  - W2: IoT Machine – Challenge 2
  - W3: Three initial design concepts
  - W4: Design concept
  - W5: Key design requirements
  - W6: Final IoT Concept & NEXPO
  - W7: Final deliverable (Concept document) & exam

# Evaluation criteria

1. HexMachine, 20% (presence/compensations)
2. NEXPO22, 20% (collaborative evaluation)
3. IoT Product Concept Document, 20% (coverage/argumentation)
4. Team Process Contribution, 20% (peer evaluation)
5. Exam, 20% (5 open text questions)

- If you are absent, reading assignments will be assigned to you – and you need to catch up with your team