Basics of Embedded Systems

Prof. Kurian Polachan, IIIT-Bangalore

Overview

- **Introduction to Embedded Systems (types, SoC etc.,)**
- **SoC Pins – GPIOs, Supply Pins, Special Function Pins**
- **Safe handling of SoC – Supply Limits, IO limits, ESD, Heat Sink**
- **Digital Blocks – PWM, Counter**
- **Analog Blocks – ADC, DAC**
- **Communication Blocks – I2C, SPI and UART**
- **Processor, FLASH, RAM, ROM, Programming and Interrupt Handling**

Introduction

Generic vs. Embedded

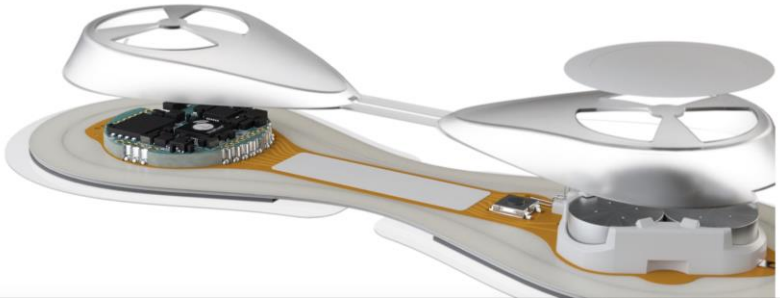
Ref: Pictures from Creative Commons

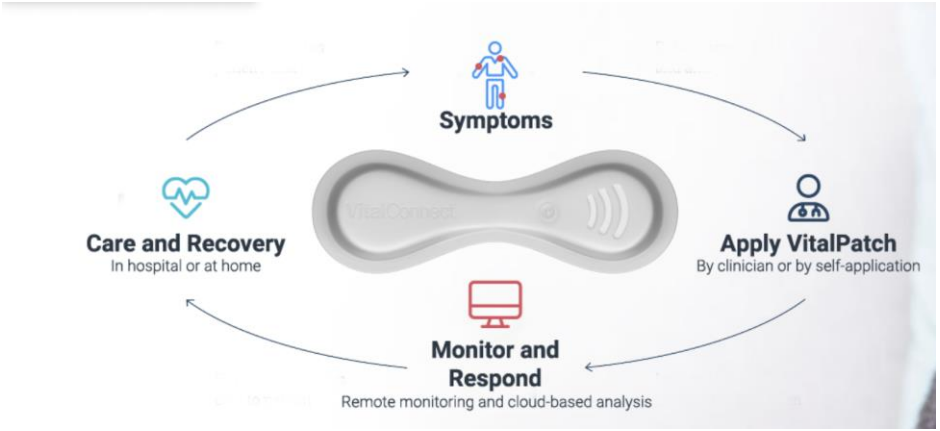
Ref: Pictures from Creative Commons

ES → Performs a Specific Function

E.g., Cardiac Monitor

Sense and Stream Electrocardiogram



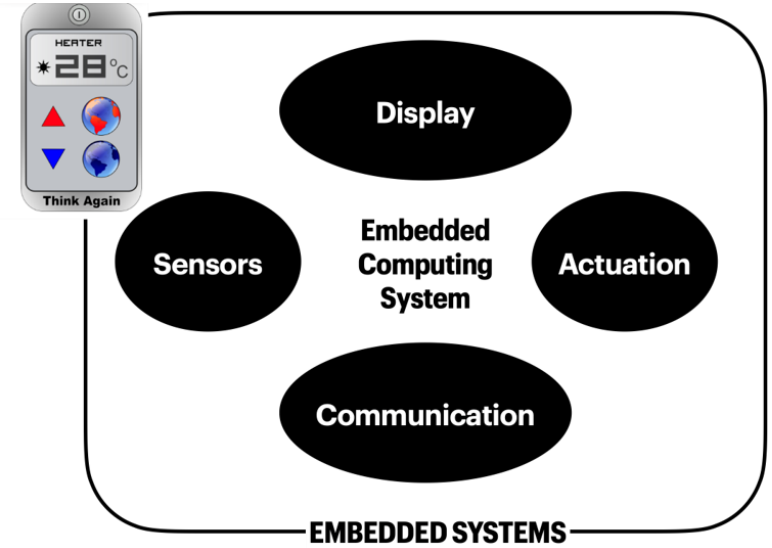


https://vitalconnect.com/cardiac-monitoring/

System Components

Thermostat → Regulates Room Temperature

Actuates Furnace when $T_{Room} < T_{Set}$



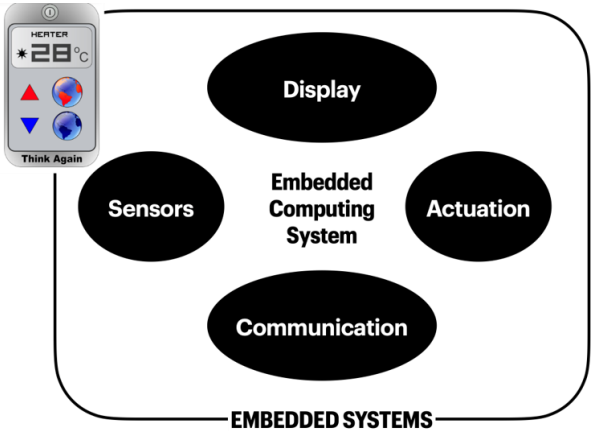
Ref: Nest Thermostat

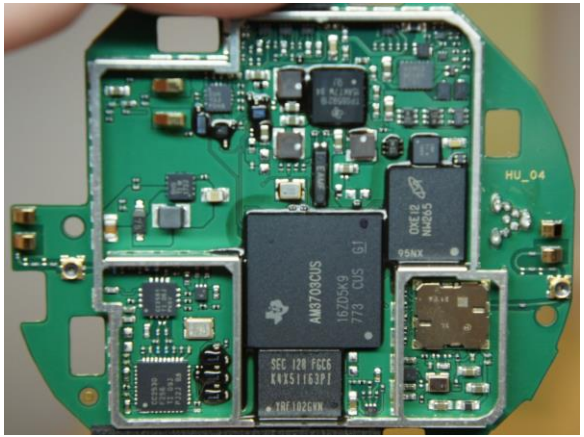
Introduction to SoC

Prof. Kurian Polachan, IIIT-Bangalore

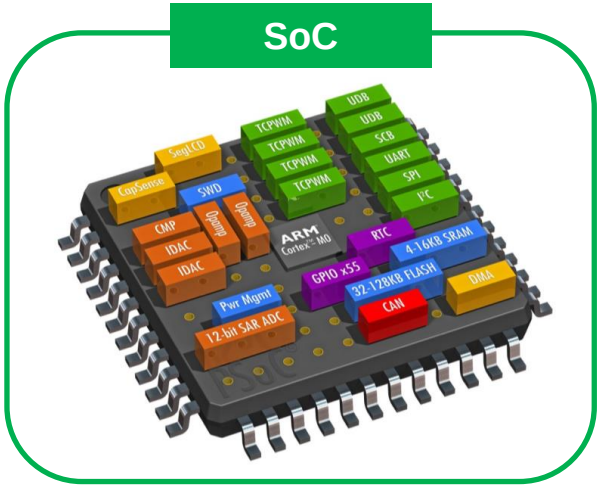
System On a Chip

SoC → Combines Circuits for Sensing, Actuation, Computation, Communication, UI and Display to a Single IC



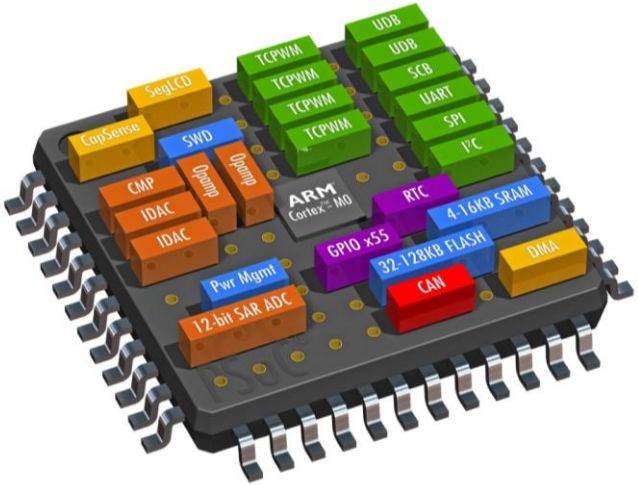


Ref: https://learn.sparkfun.com/tutorials/nest-thermostat-teardown-/all

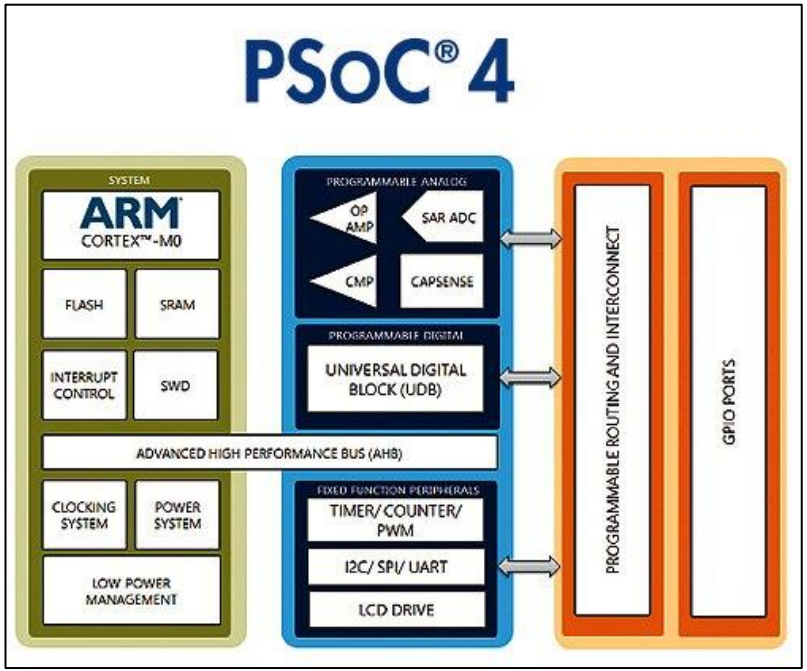


Ref: PSoC, a mixed-signal SoC from Infineon Technologies

e.g., PSoC

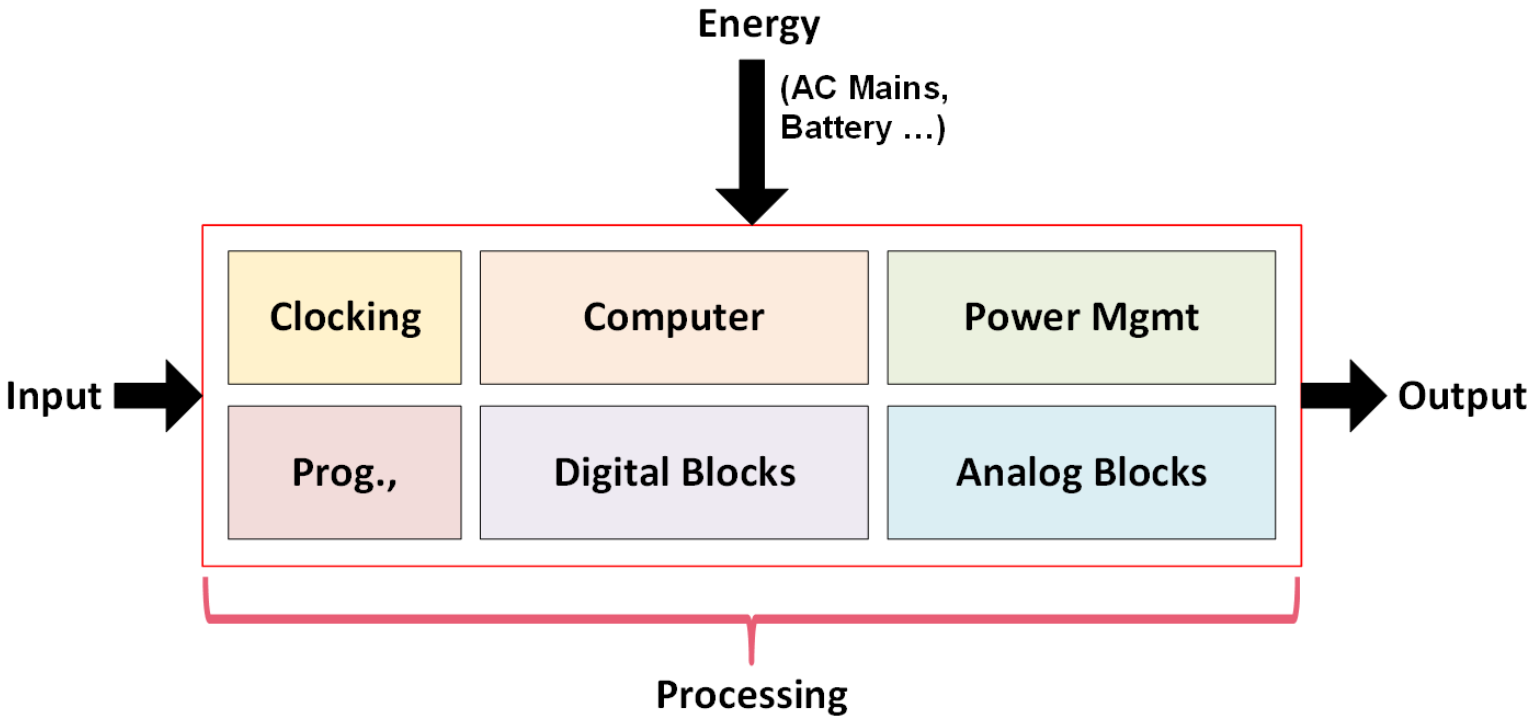


Ref: PSoC, a mixed-signal SoC from Infineon Technologies



https://community.element14.com/products/devtools/technicallibrary/w/documents/11058/cypress-psoc-4-system-on-chip-overview

SoC Abstract



Embedded System Types

Real-Time Systems

Embedded Systems with Strict Time Constraint

Ref: Nest Thermostat

Thermostat

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Airbag (In-Vehicle)

This Photo by Unknown Author is licensed under CC BY-SA-NC

Railway Crossing

Low-Power Systems

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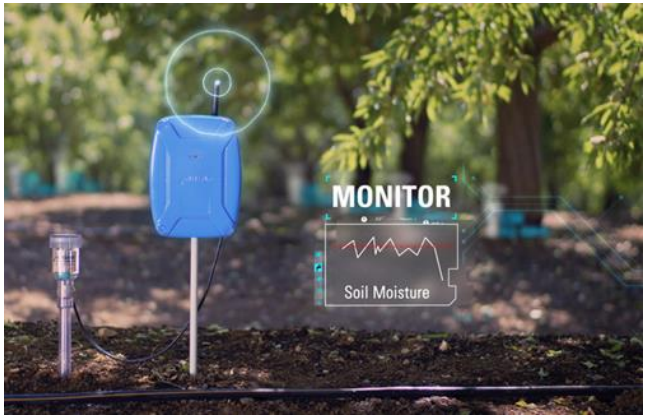
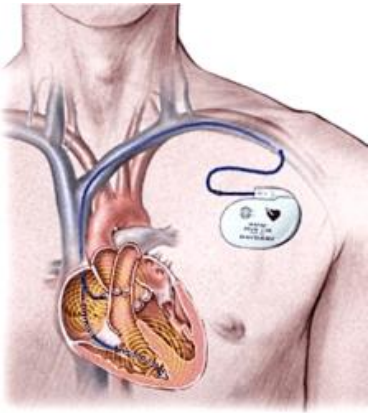
Car Navigation



https://www.netafim.com/

✔ **Soil Moisture Sensor**



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✔ **Pacemaker**

Mobile Systems

Ref: Nest Thermostat

Thermostat

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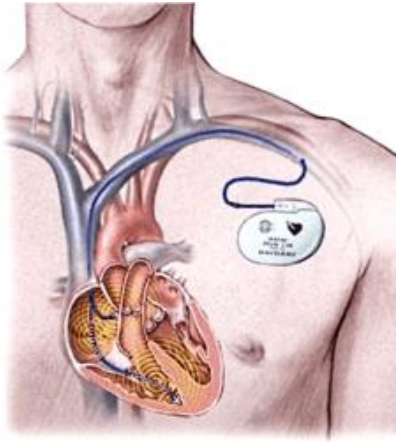
✔ **Electric Brush**



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Pacemaker

✔ **Apple AirTag**

Standalone Systems

Ref: Nest Thermostat

Thermostat

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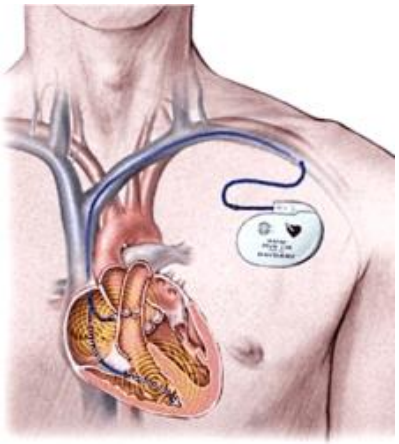
✔ **Electric Brush**



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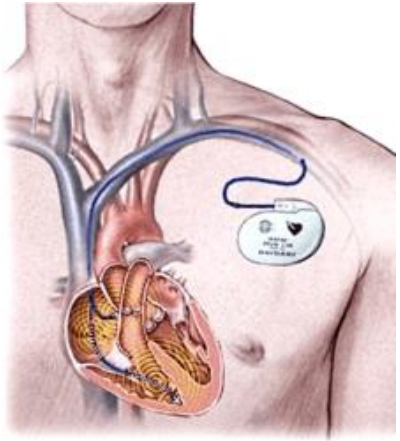
✔ **Pacemaker**

Apple.com

Apple AirTag

Battery-Free Systems

Harvests Energy for Operation



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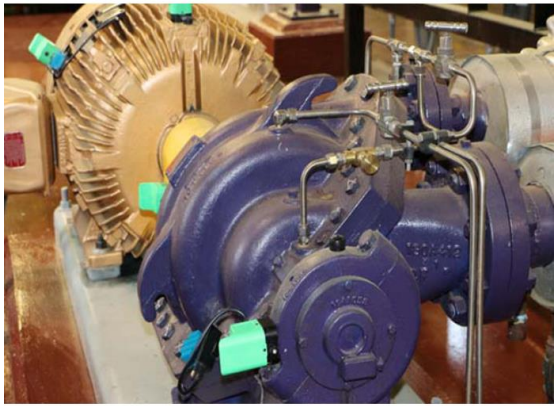
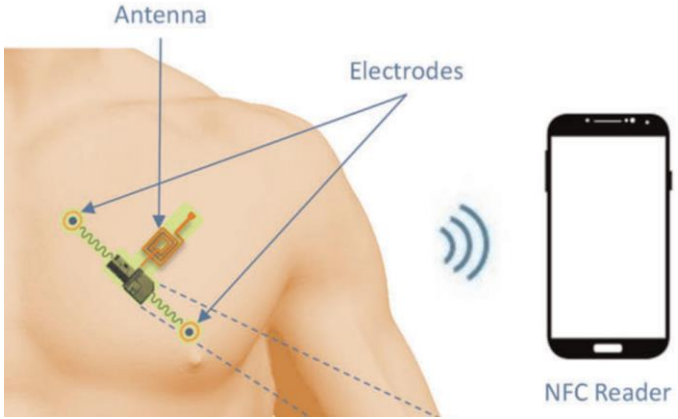
Pacemaker



Everactive - https://everactive.com/

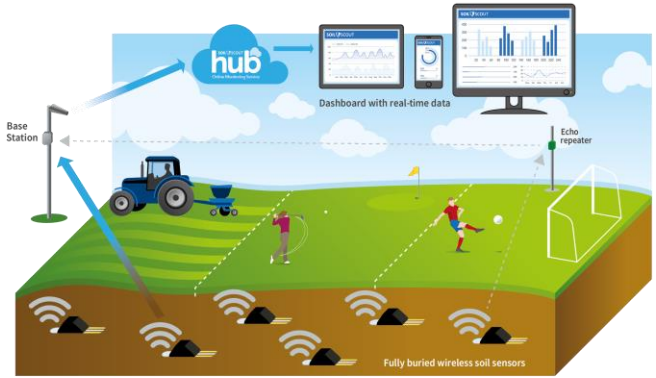
✔ **Industrial Sensor Nodes**



Zulqarnain, Mohammad, et al. "A flexible ECG patch compatible with NFC RF communication." npj Flexible Electronics 4.1 (2020): 1-8.

✔ **Battery-Free ECG Patch**

Networked Systems



https://soilscout.com/solution/wireless-soil-moisture-sensor

Calculator

✓ **Soil Sensor Network**

✓ **Smart Home Network**

IoT vs. Networked Sys

IoT = Nodes are Part of the Internet

Nodes Have IP Address and Can Connect to the Internet