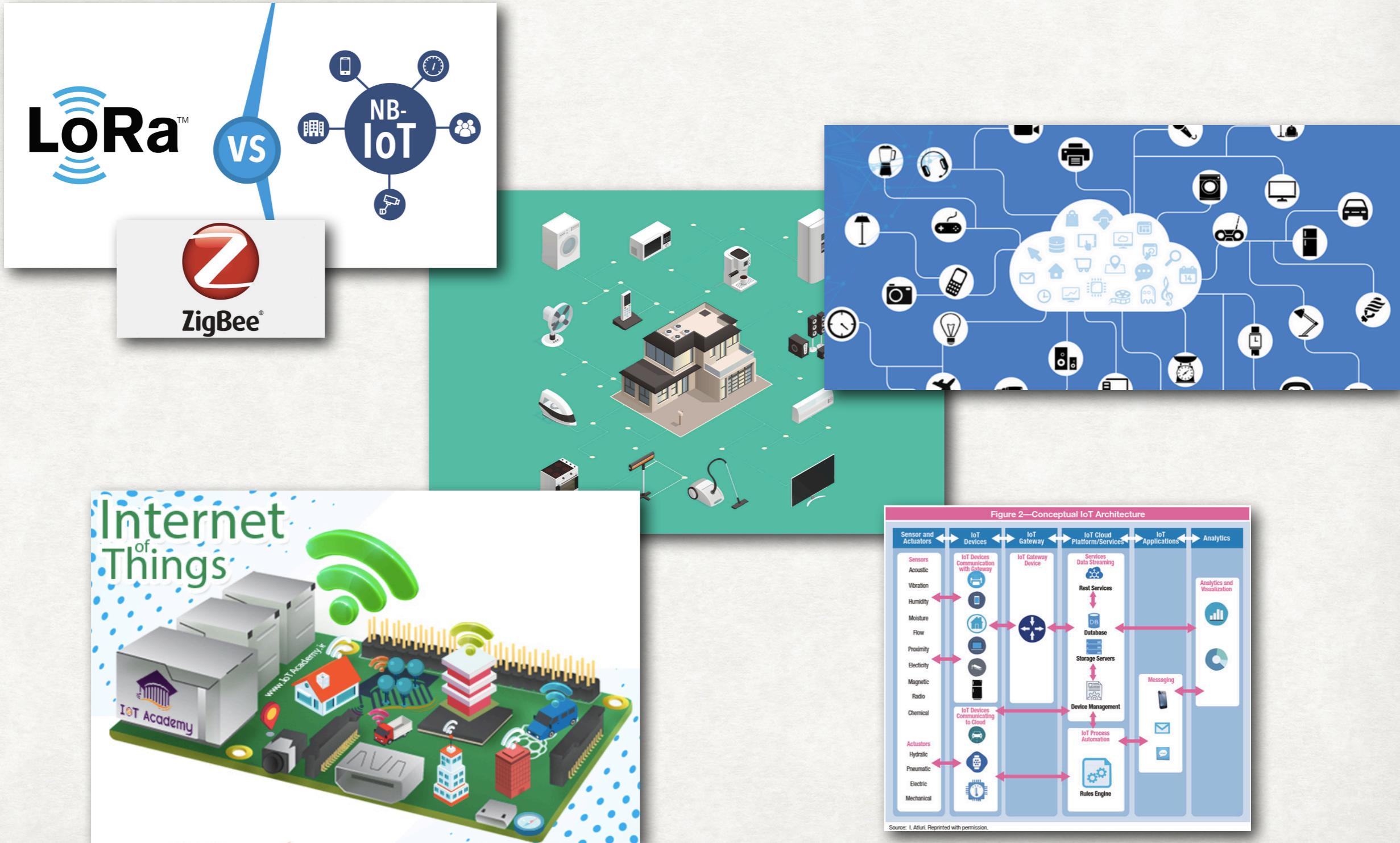


Project #2: Internet of Things (IoT)

Internet of Things



Internet of Things

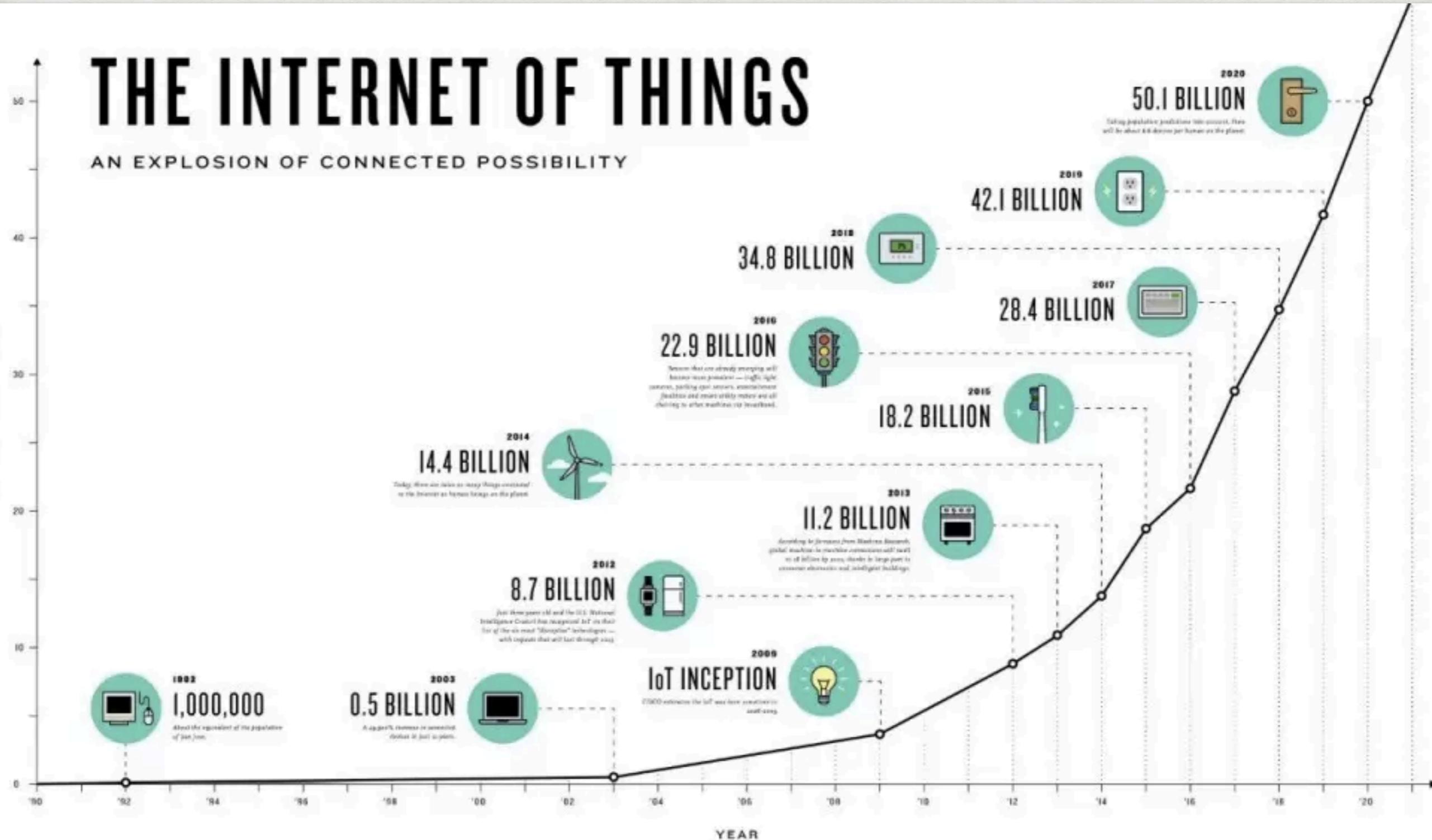


Internet of Things

THE INTERNET OF THINGS

AN EXPLOSION OF CONNECTED POSSIBILITY

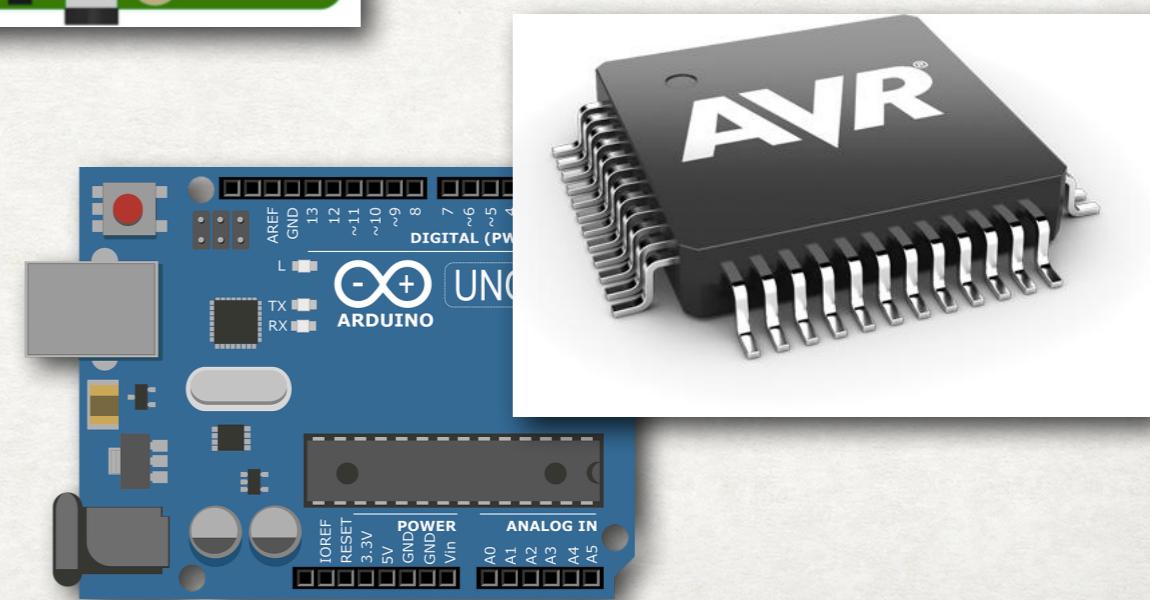
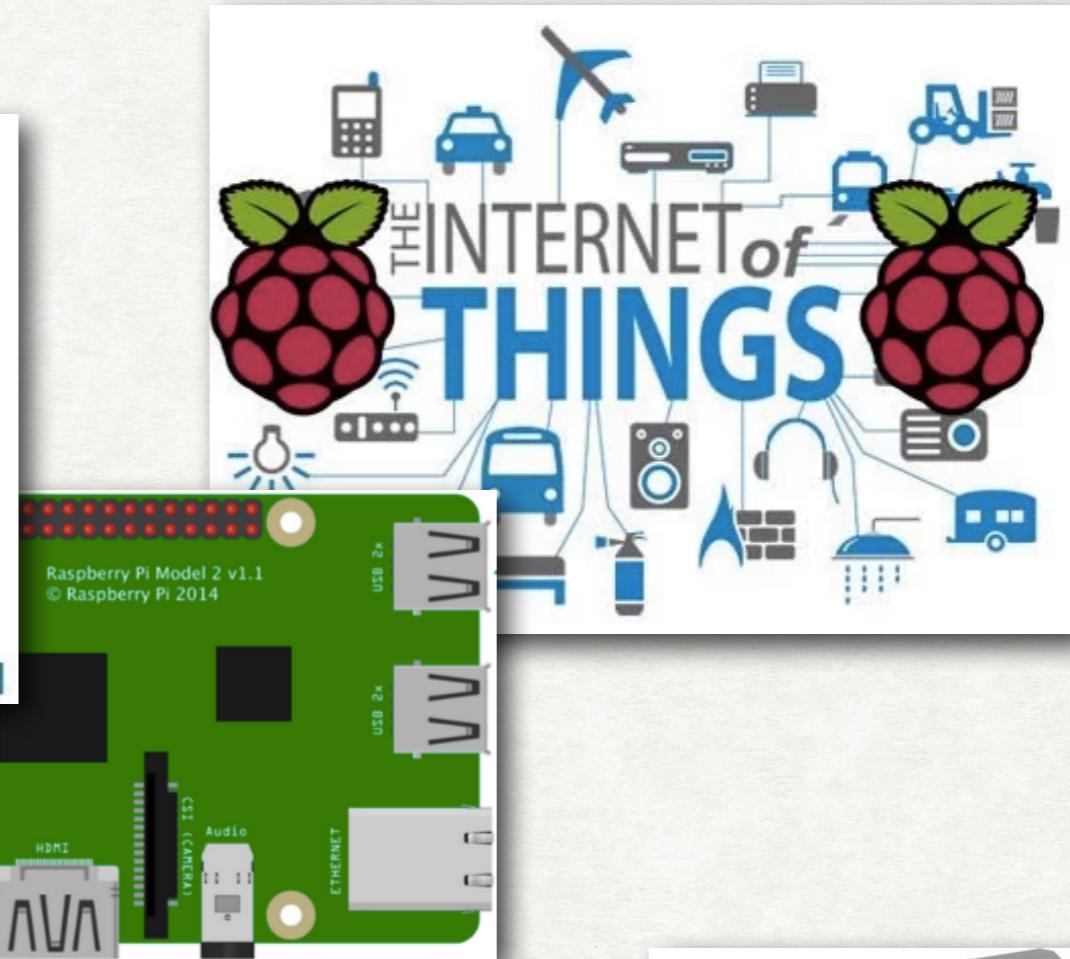
BILLIONS OF DEVICES



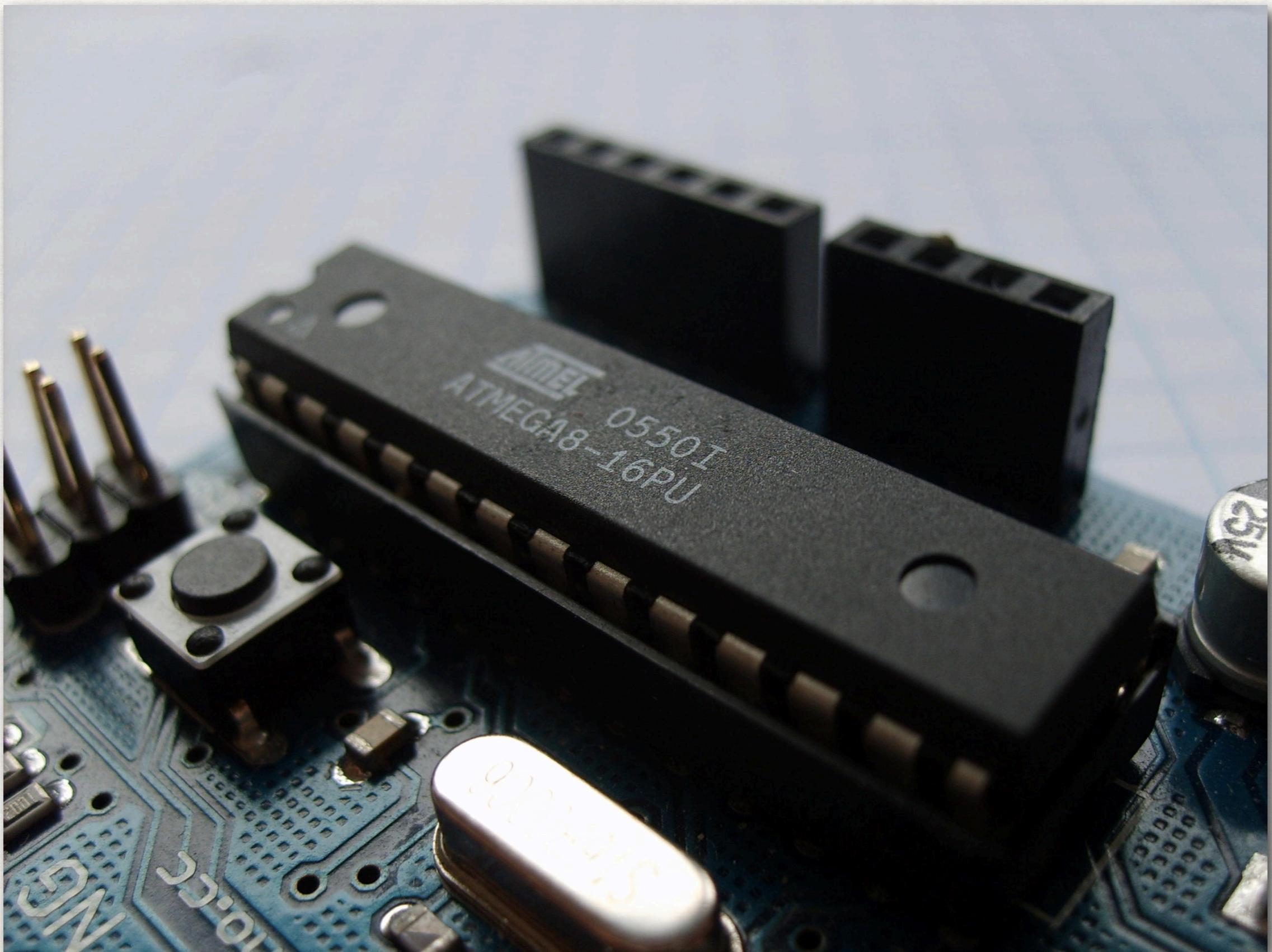
Internet of Things Essential

- **Embedded system with sensor/actuator and communication capability on the edge.**
- Cloud/BigData platform for offloading storage/computation intensive tasks.
- Strategy/algorithm to close the data/value loop.

Embedded System



Embedded System: 8bit MCU: AVR8



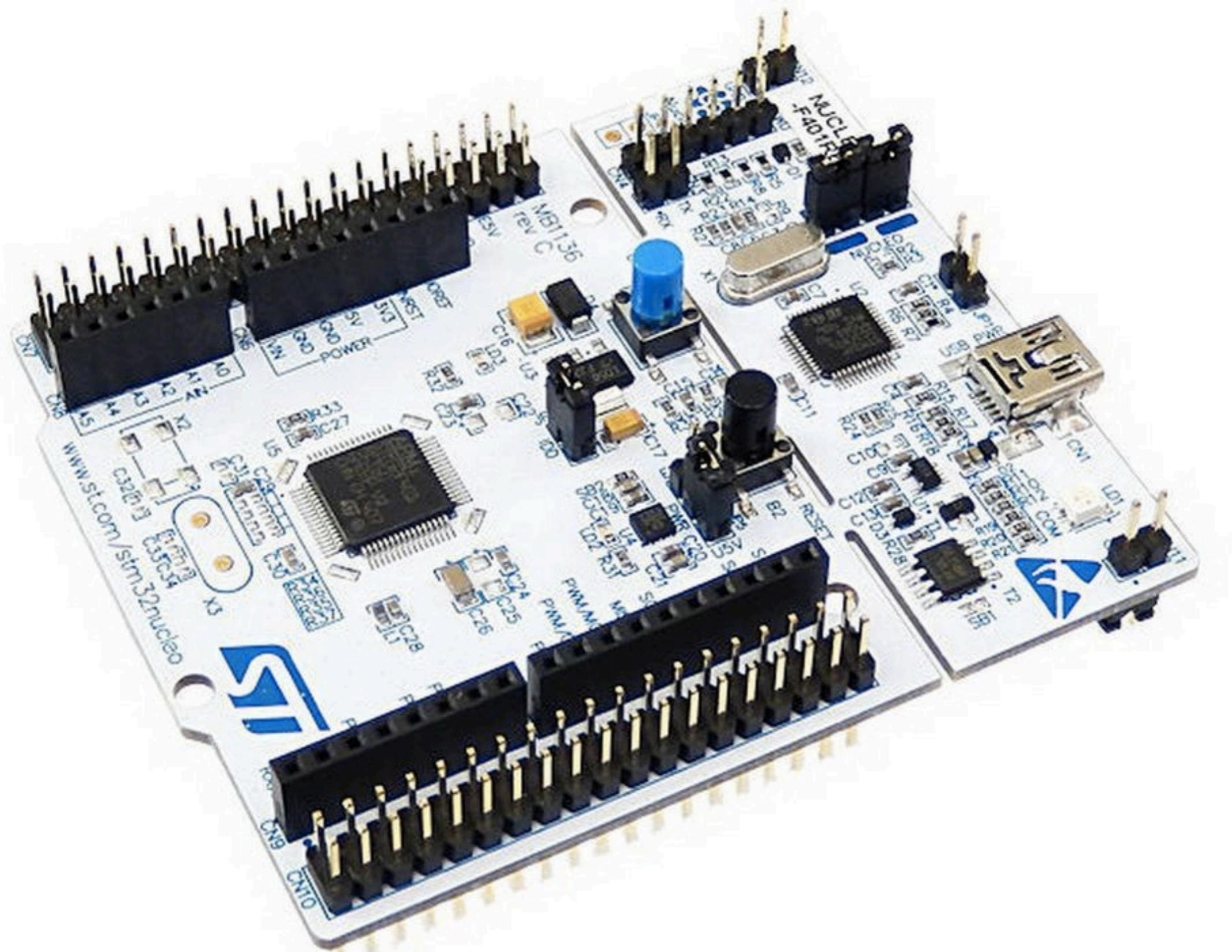
Embedded System: 8bit MCU: AVR8

Peripheral Features

- Two 8-bit Timer/counters with separate prescaler and Compare mode
- One 16-bit Timer/counter with separate prescaler, Compare mode, and Capture mode
- Real time counter with separate oscillator
- Six PWM channels

- 8-channel 10-bit ADC in TQFP and QFN/MLF package
 - Temperature measurement
- 6-channel 10-bit ADC in PDIP package
 - Temperature measurement
- Two master/slave SPI serial interface
- One programmable serial USART
- One byte-oriented 2-wire serial interface (Philips I²C compatible)
- Programmable watchdog timer with separate on-chip oscillator
- One on-chip analog comparator
- Interrupt and wake-up on pin change

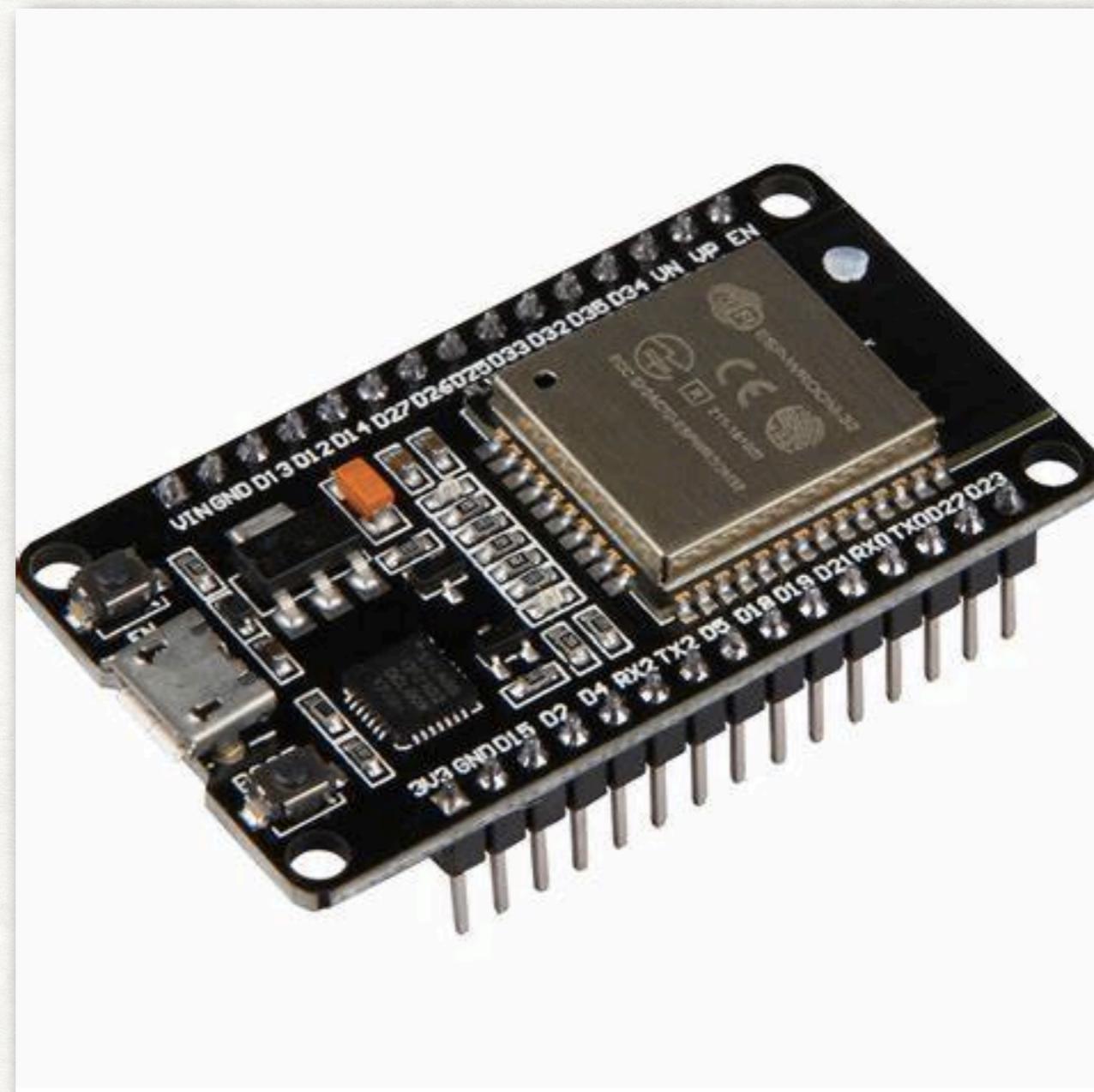
Embedded System: 32bit MCU: STM32



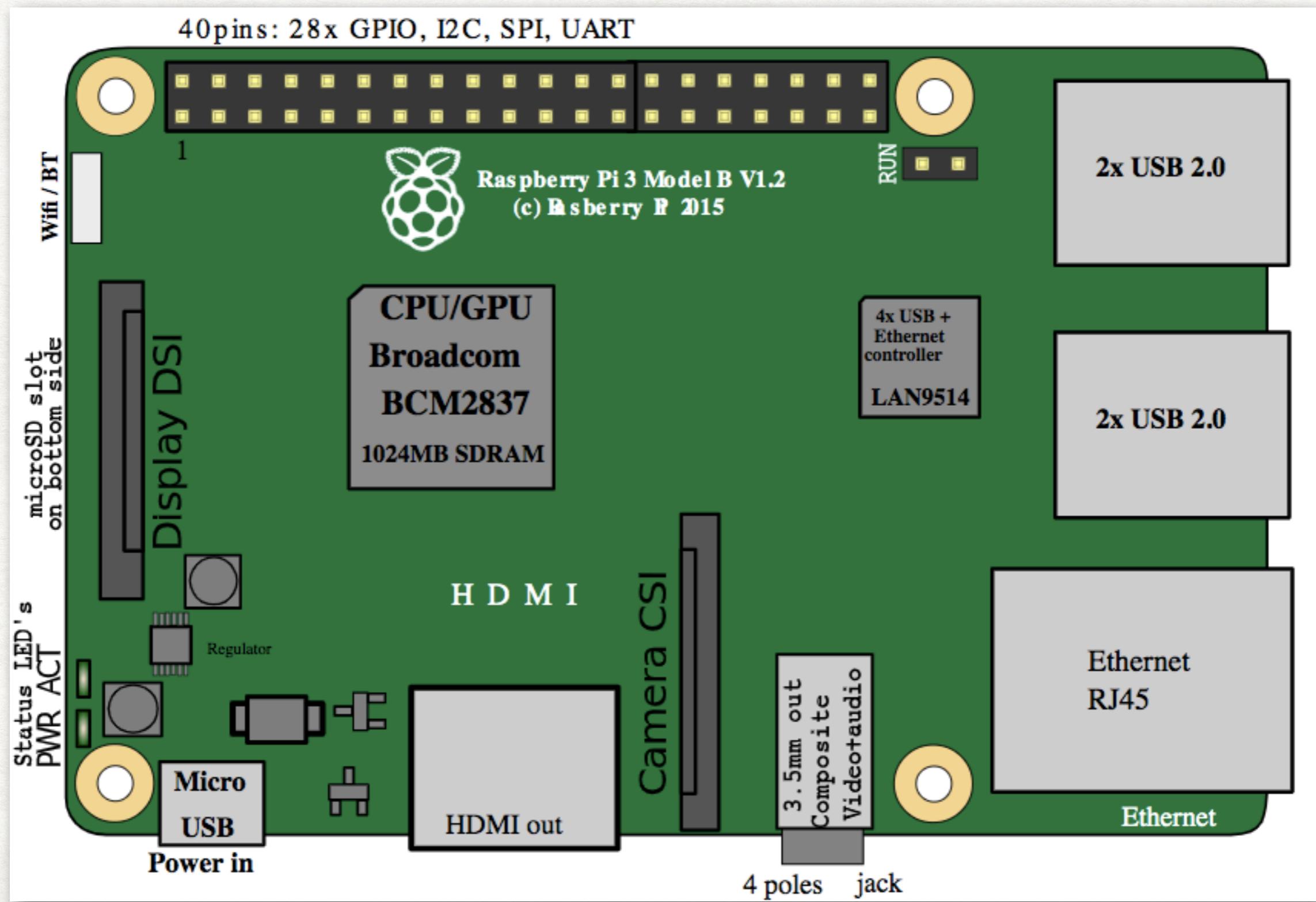
Embedded System: 32bit MCU: STM32

- 2 x 12-bit, 1 μ s A/D converters (up to 16 channels)
 - Conversion range: 0 to 3.6 V
 - Dual-sample and hold capability
 - Temperature sensor
- DMA
 - 7-channel DMA controller
 - Peripherals supported: timers, ADC, SPIs, I²Cs and USARTs
- Up to 80 fast I/O ports
 - 26/37/51/80 I/Os, all mappable on 16 external interrupt vectors and almost all 5 V-tolerant
- 7 timers
 - Three 16-bit timers, each with up to 4 IC/OC/PWM or pulse counter and quadrature (incremental) encoder input
 - 16-bit, motor control PWM timer with dead-time generation and emergency stop
 - 2 watchdog timers (Independent and Window)
 - SysTick timer 24-bit downcounter
- Up to 9 communication interfaces
 - Up to 2 x I²C interfaces (SMBus/PMBus)
 - Up to 3 USARTs (ISO 7816 interface, LIN, IrDA capability, modem control)
 - Up to 2 SPIs (18 Mbit/s)
 - CAN interface (2.0B Active)
 - USB 2.0 full-speed interface

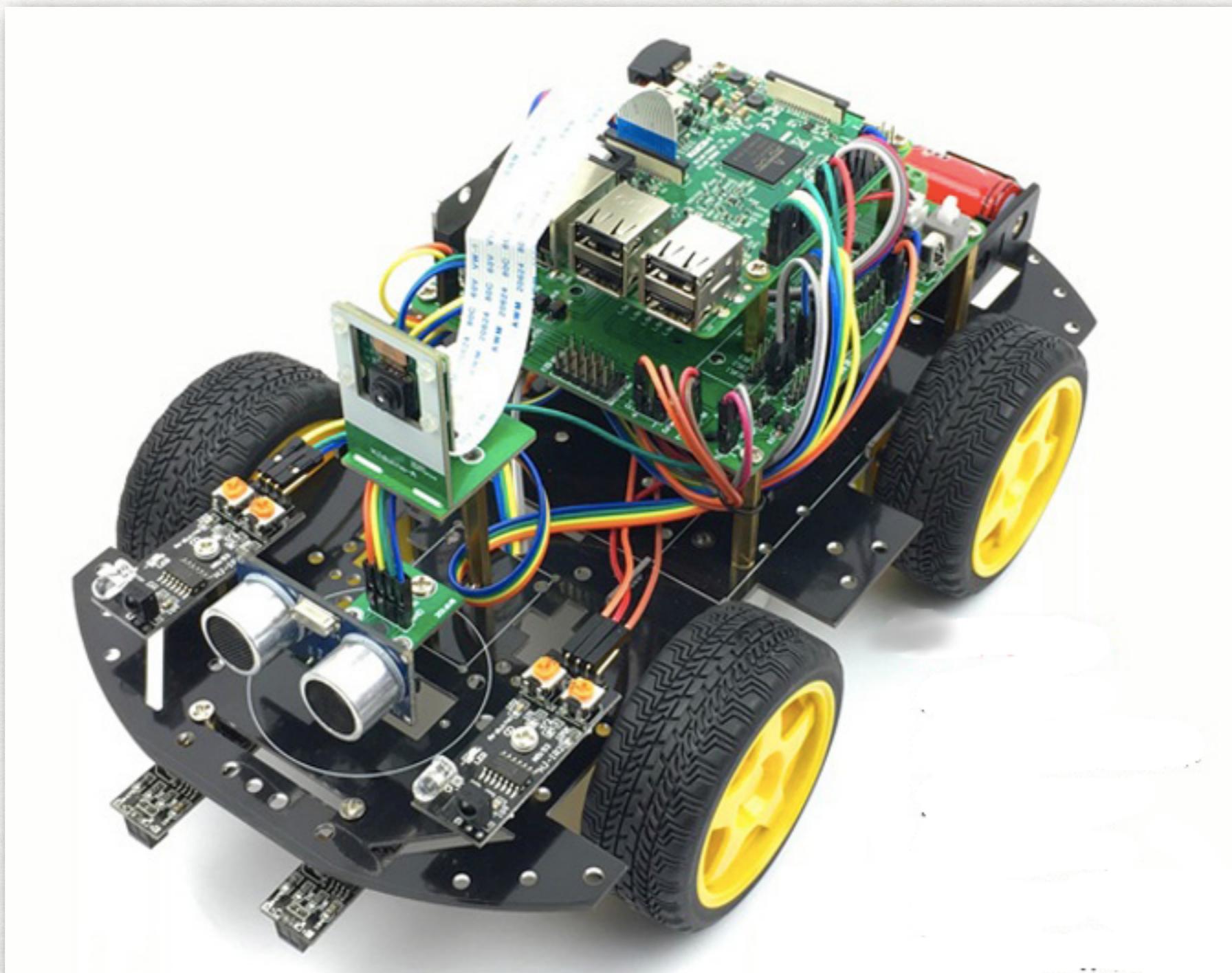
Embedded System: 32bit MCU x2: ESP32



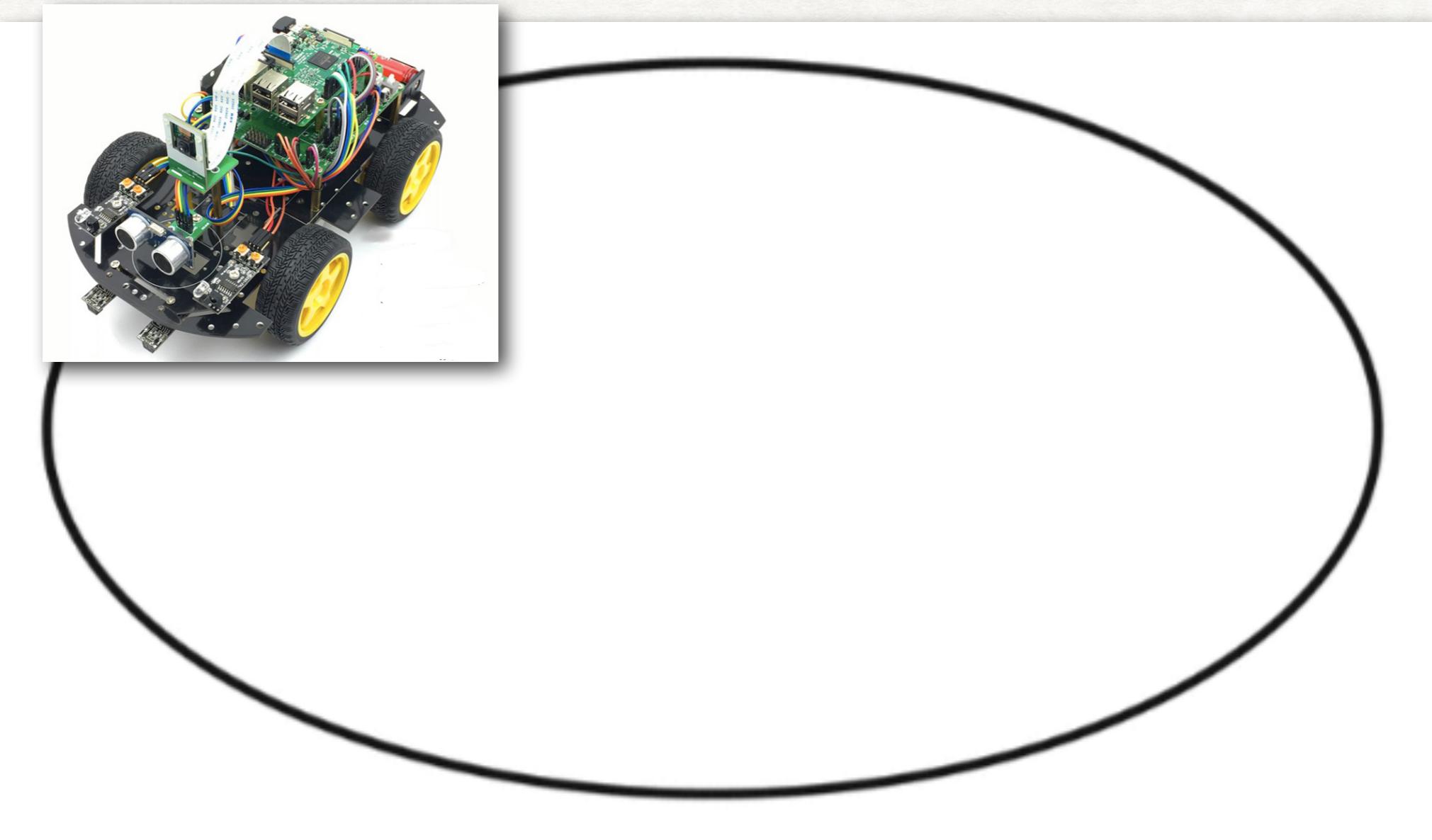
Embedded System: Single Board Computer: Raspberry Pi



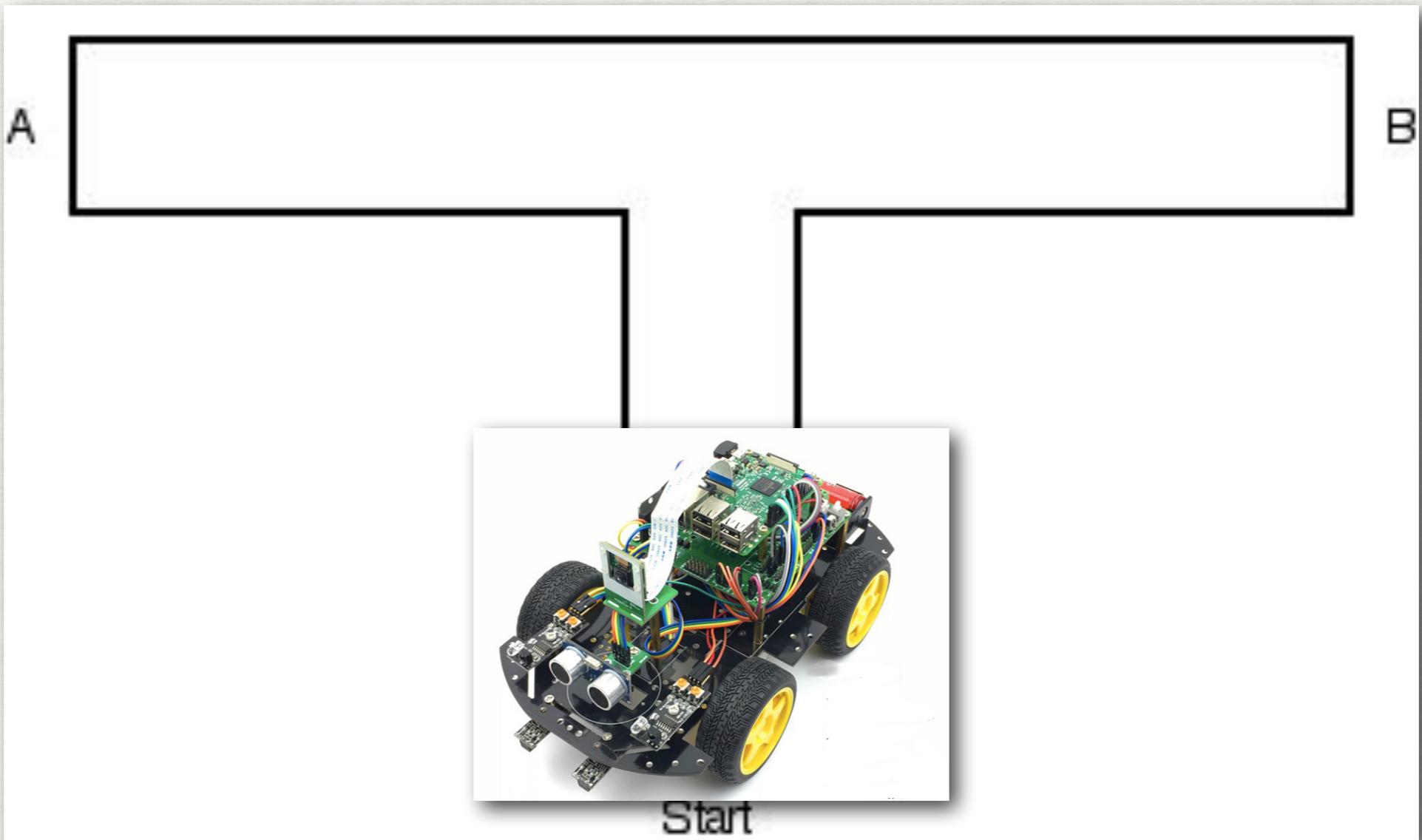
Intelligent Car



Intelligent Car: Line Tracking



Intelligent Car: T Maze (SLAM)



Intelligent Car: Simultaneous Localization and Mapping (SLAM)

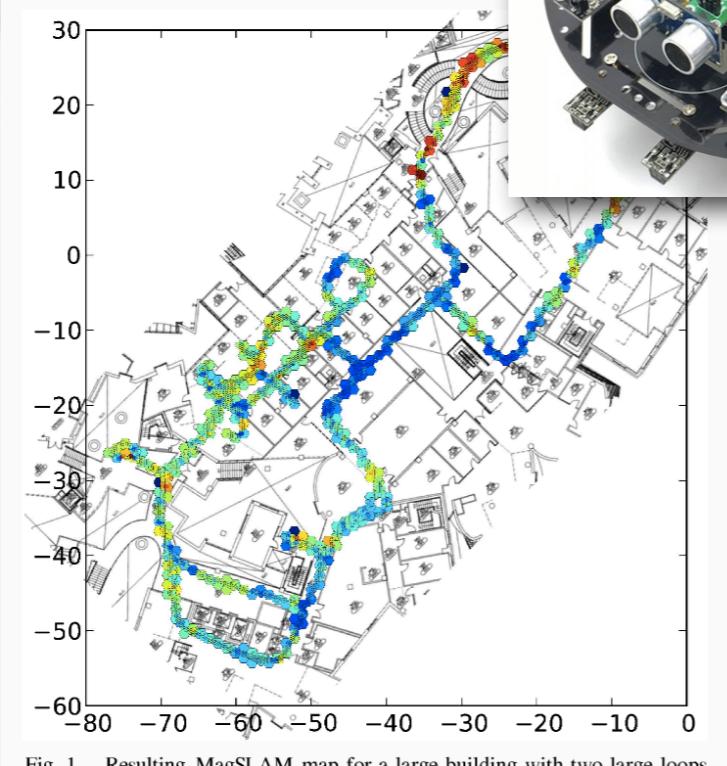
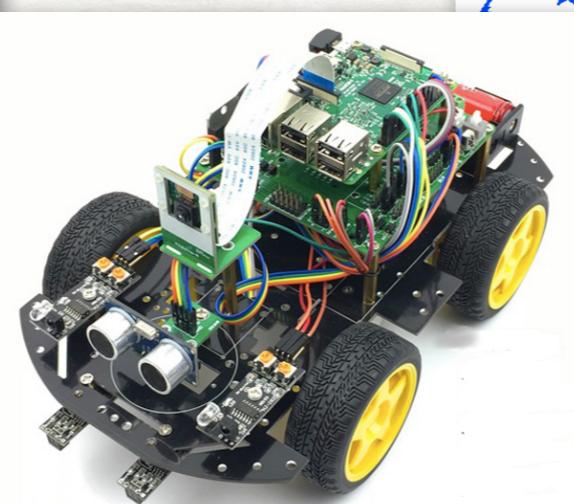
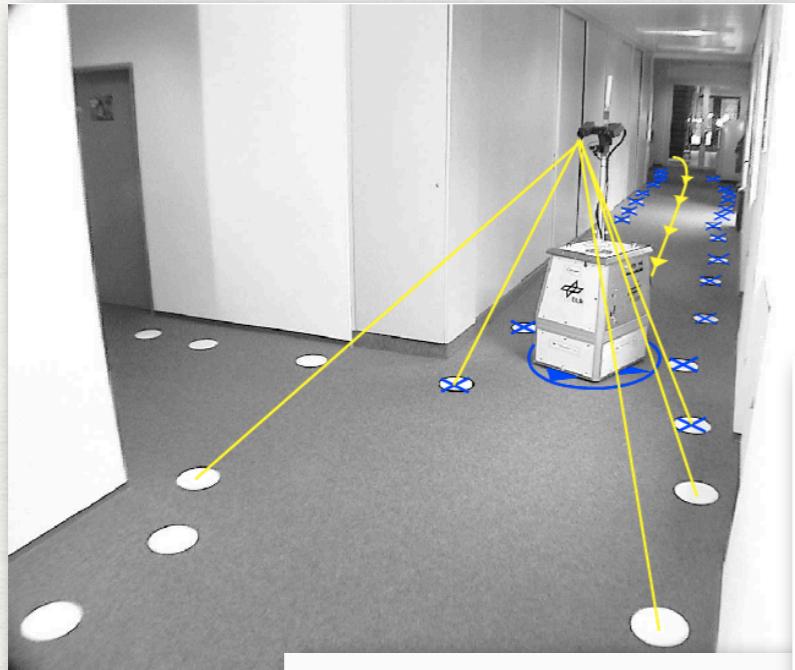
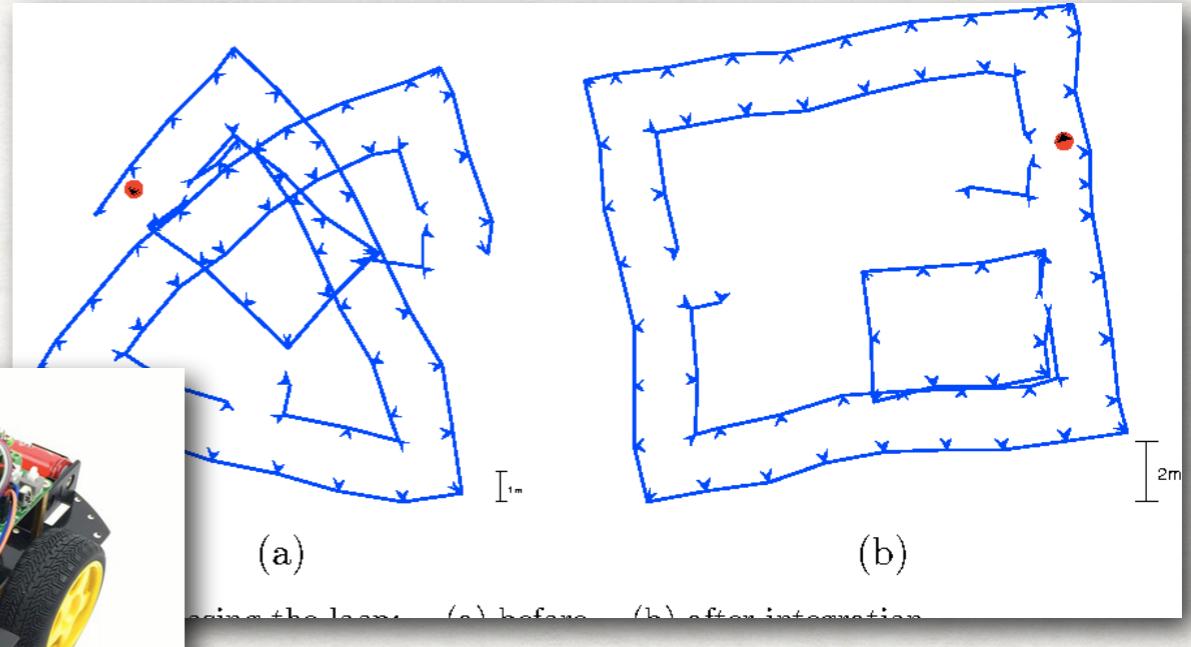
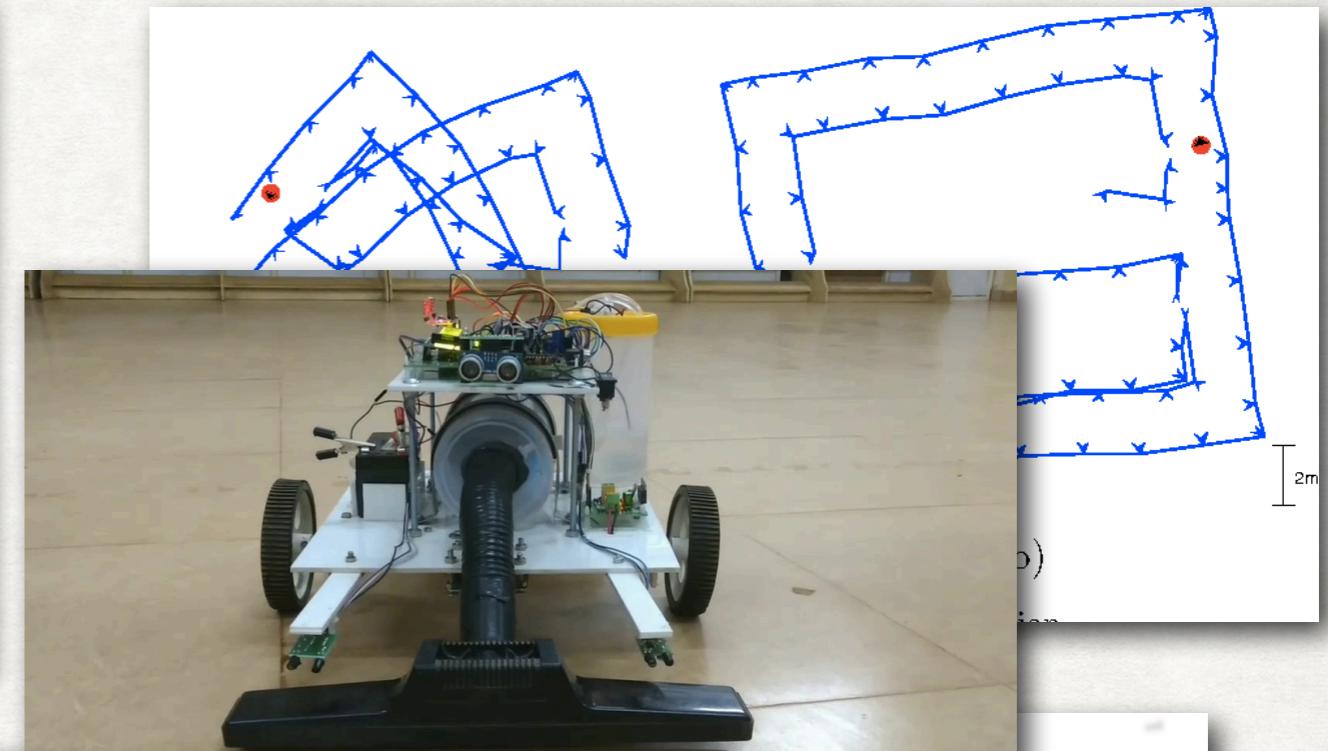


Fig. 1. Resulting MagSLAM map for a large building with two large loops



Intelligent Car: Simultaneous Localization and Mapping (SLAM)



PROJECT GOAL

- Teams build a consensus on the design of a path labeled by the black tape.
 - The path should be at least 1 meter long.
 - The total corner angle should be at least 360 degrees.
 - There should be start line and finish line or label.
- Each team builds the vehicle.
 - With a budget of ¥500.00
- Evaluation.
 - Go fast as you can!

**Next time:
3D Modeler**