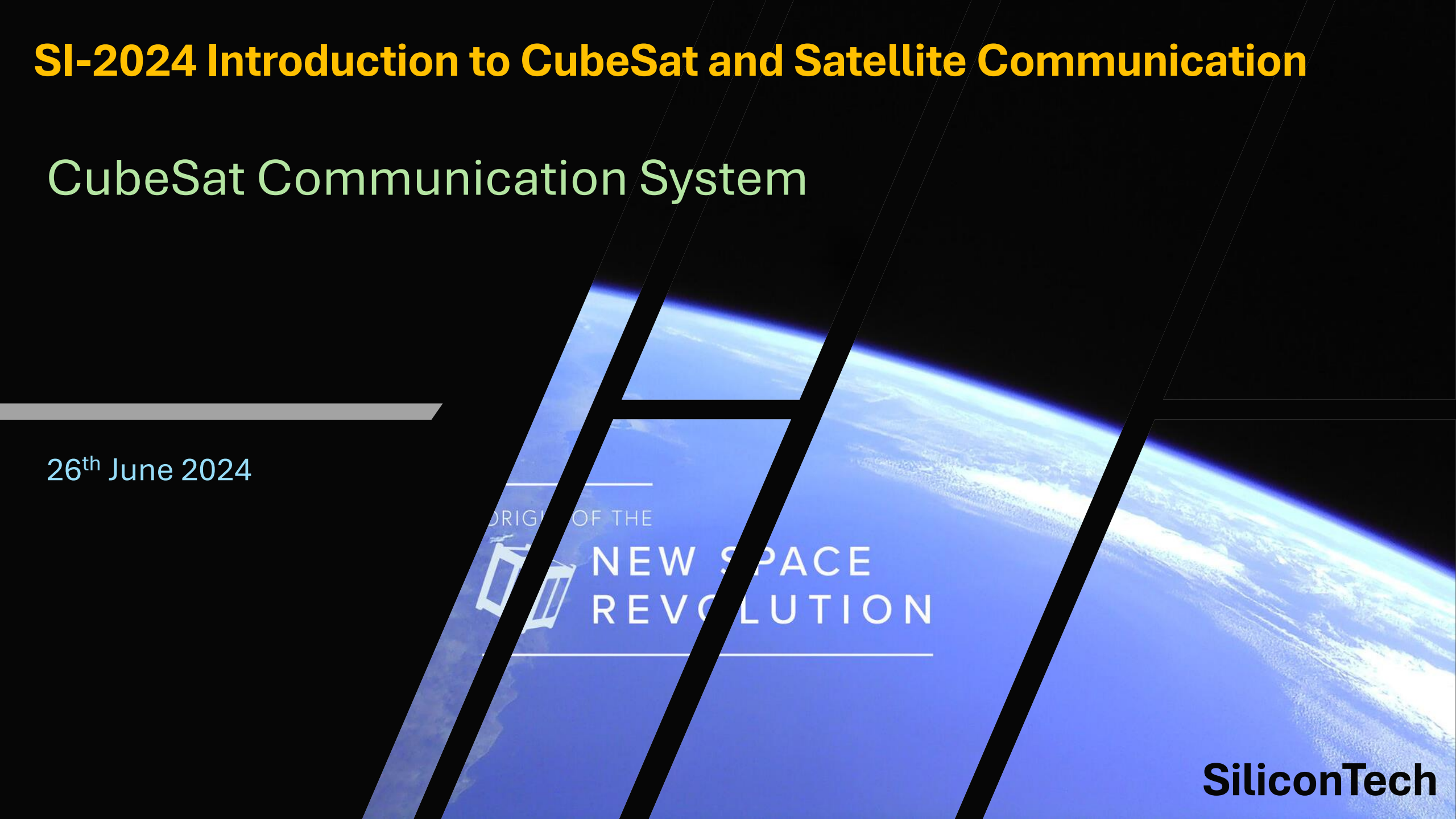
SI-2024 Introduction to CubeSat and Satellite Communication

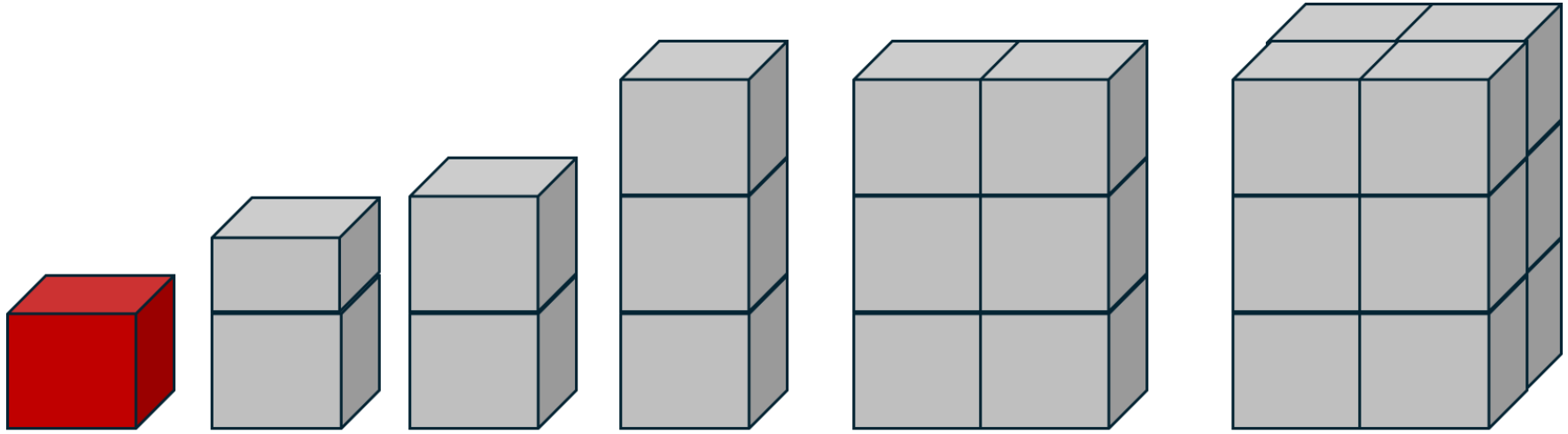
CubeSat Communication System

26th June 2024



SiliconTech

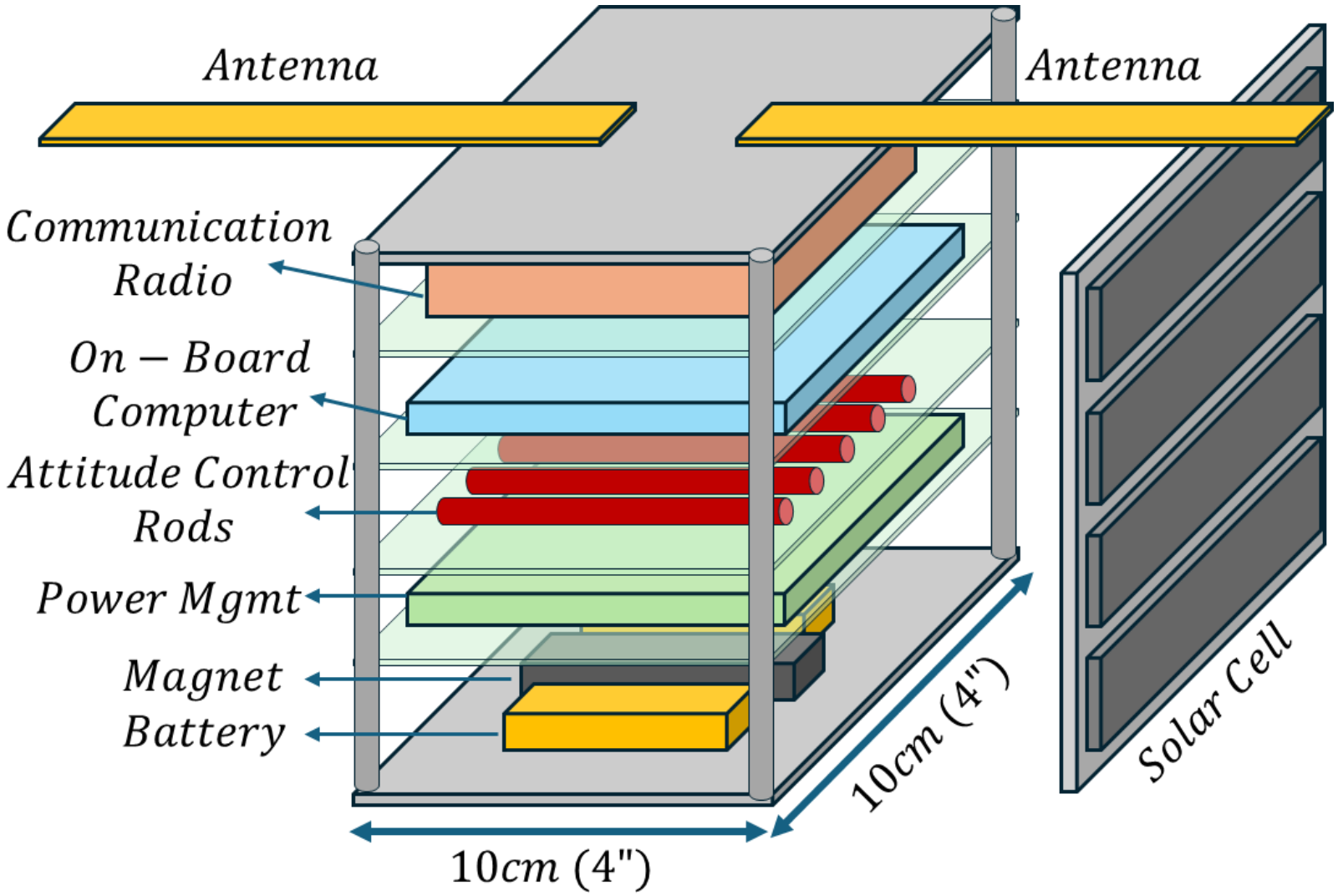
CubeSat Standard Sizes



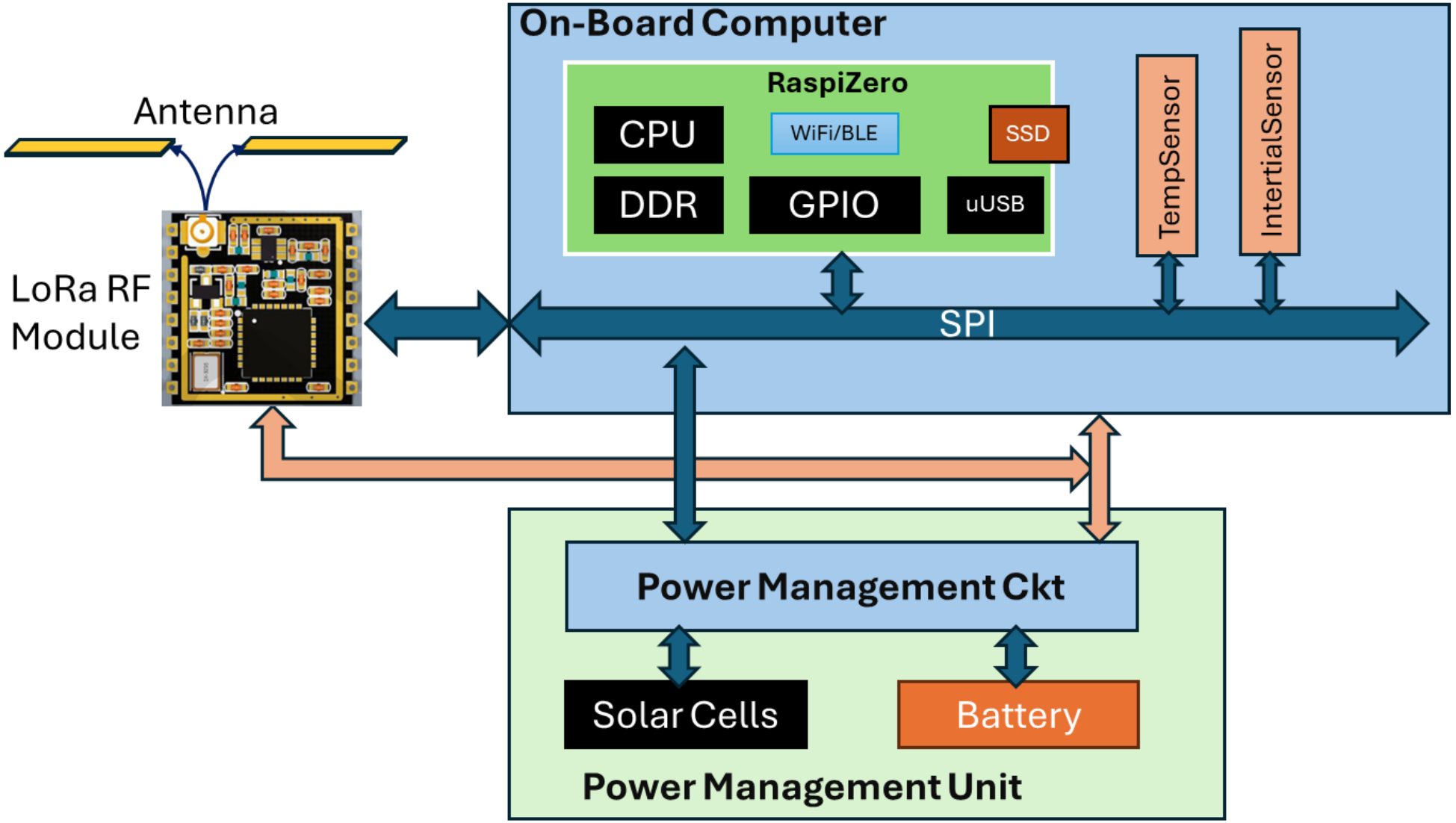
(4”x4”x4”)

Our target <1U

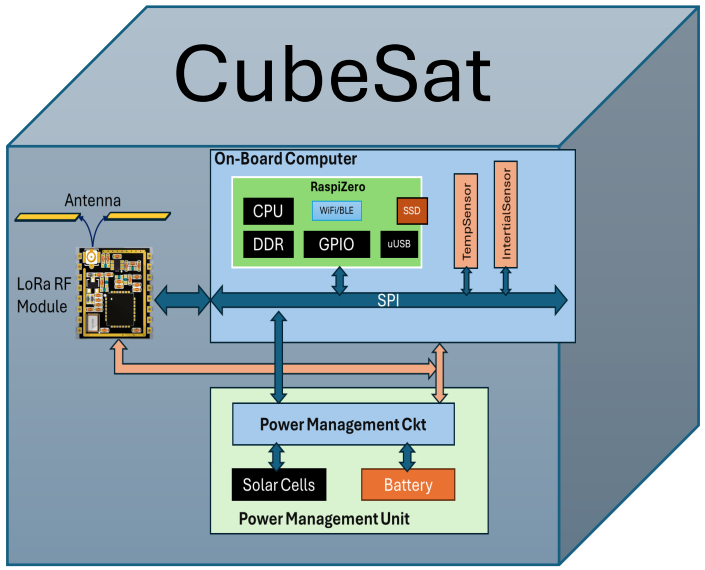
Minimal Payload

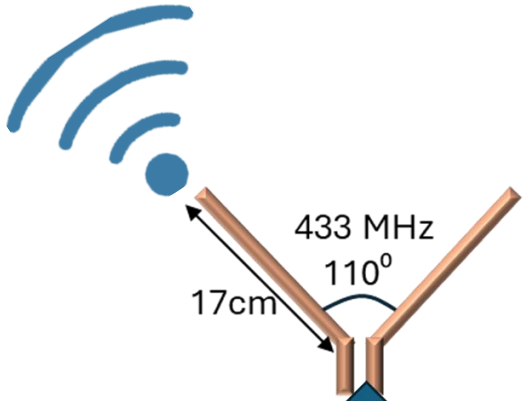


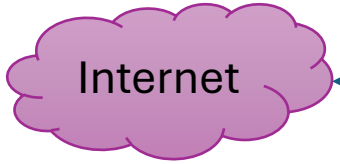
CubeSat Architecture



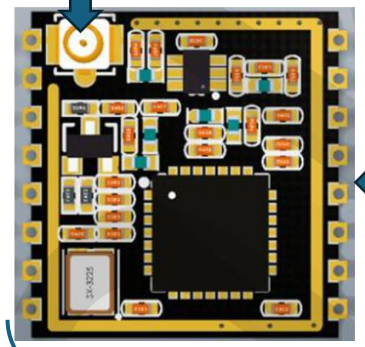
CubeSat Communication System





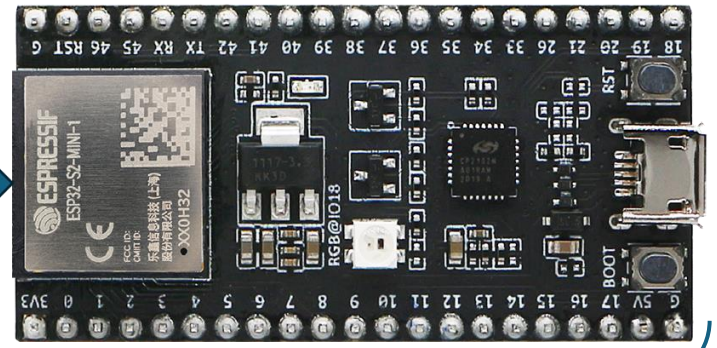


LoRa RF Module



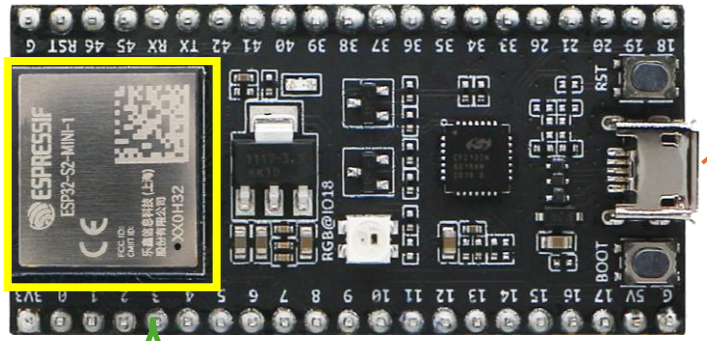
SPI

ESP 32 Dev KIT

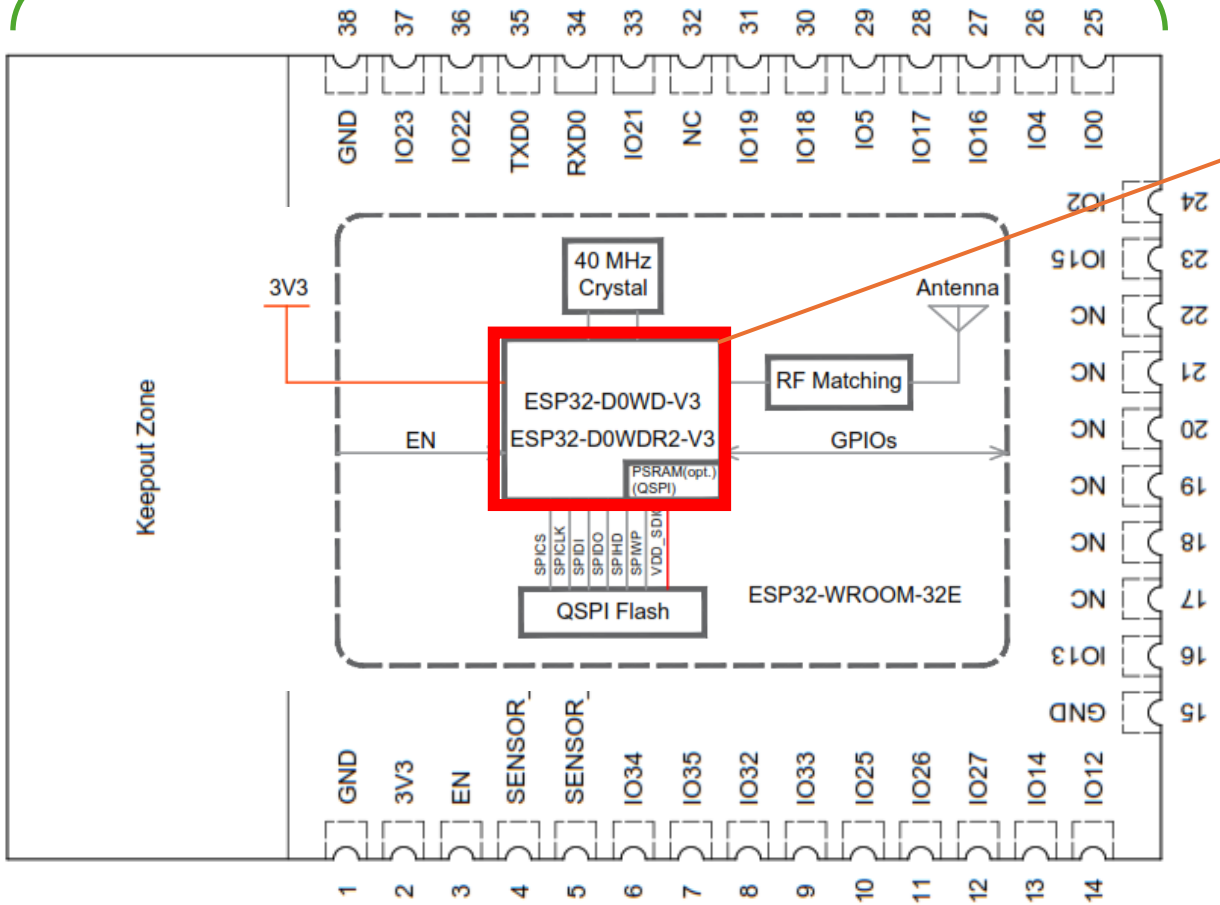


Ground Station

ESP32 Development Board

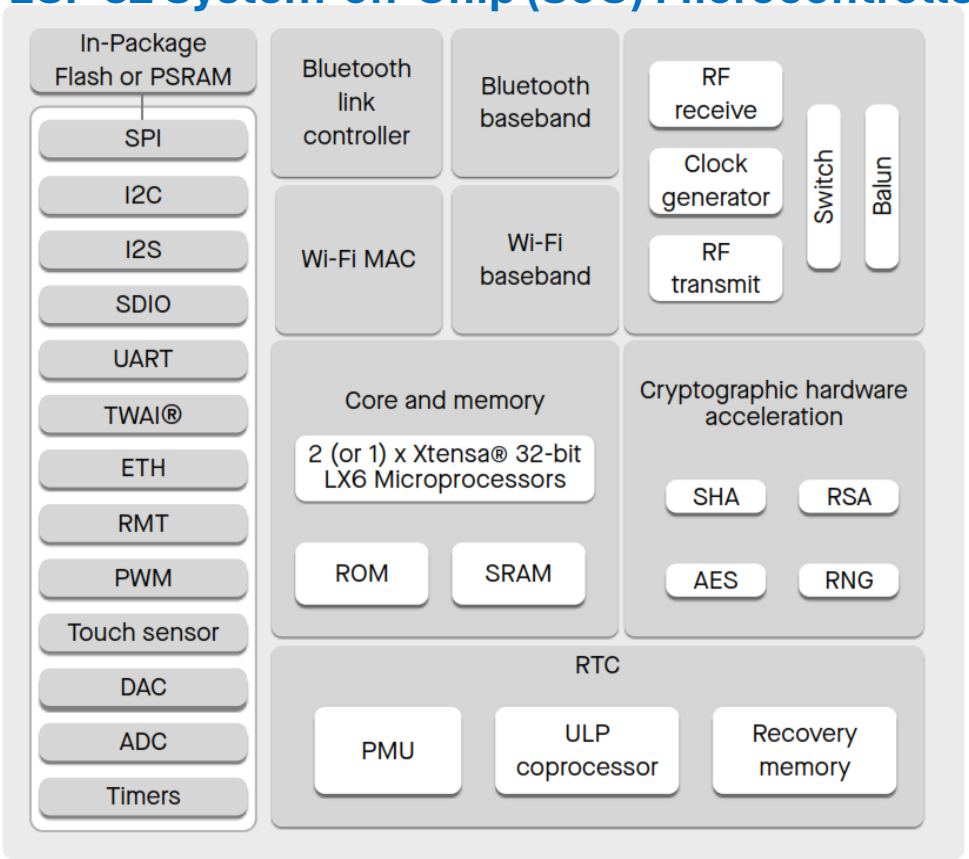


ESP 32 Module



Source: ESP32-WROOM-32E Datasheet

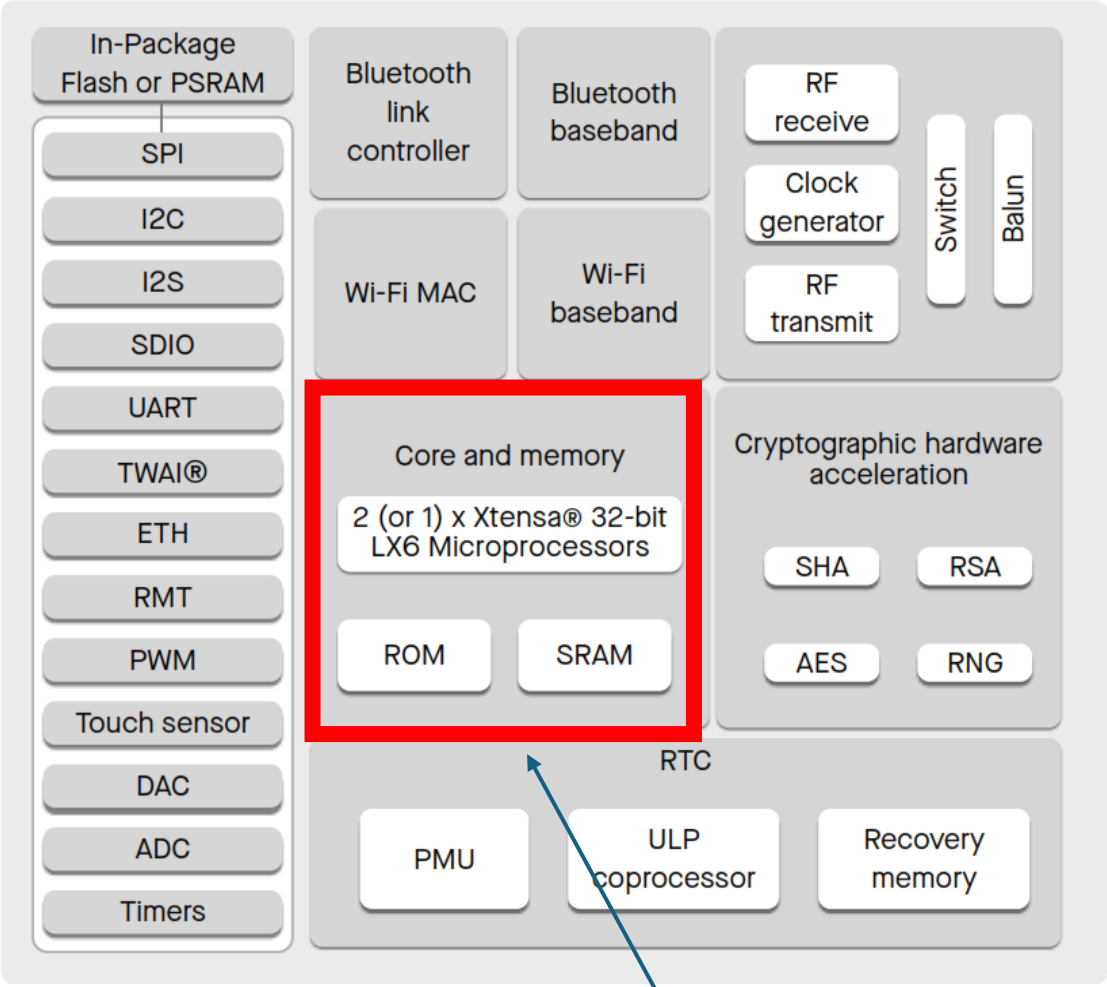
ESP 32 System-on-Chip (SoC) Microcontroller



Source: ESP32 Datasheet

Microcontroller Vs. Microprocessor

ESP 32 System-on-Chip (SoC) Microcontroller



Source: ESP32 Datasheet

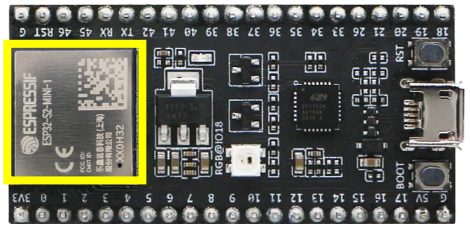
Microprocessor

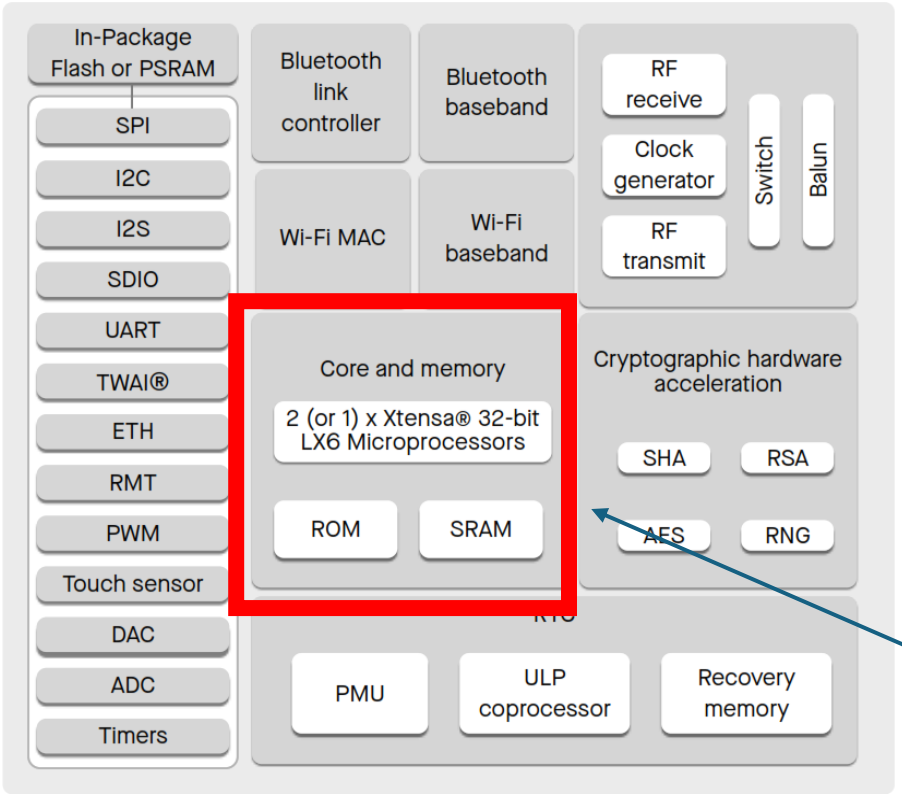
Microcontroller = Microprocessor + Peripheral

- **Peripherals:**
  - SPI/I2C/I2S/UART: Digital Serial data.
  - PWM: Pulse-Width Modulation
  - Touch Sensor: Capacitive touch screens, etc.
  - Timers
  - ADC: Analog to Digital Converter
  - DAC: Digital to Analog converter
  - Bluetooth
  - WiFi

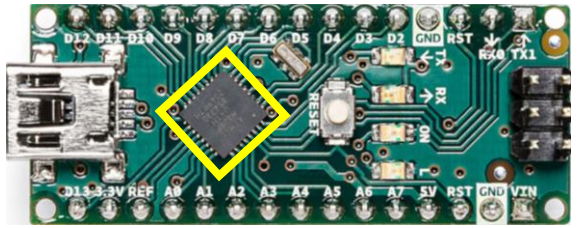
Arduino Vs ESP32

ESP 32 Development Kit

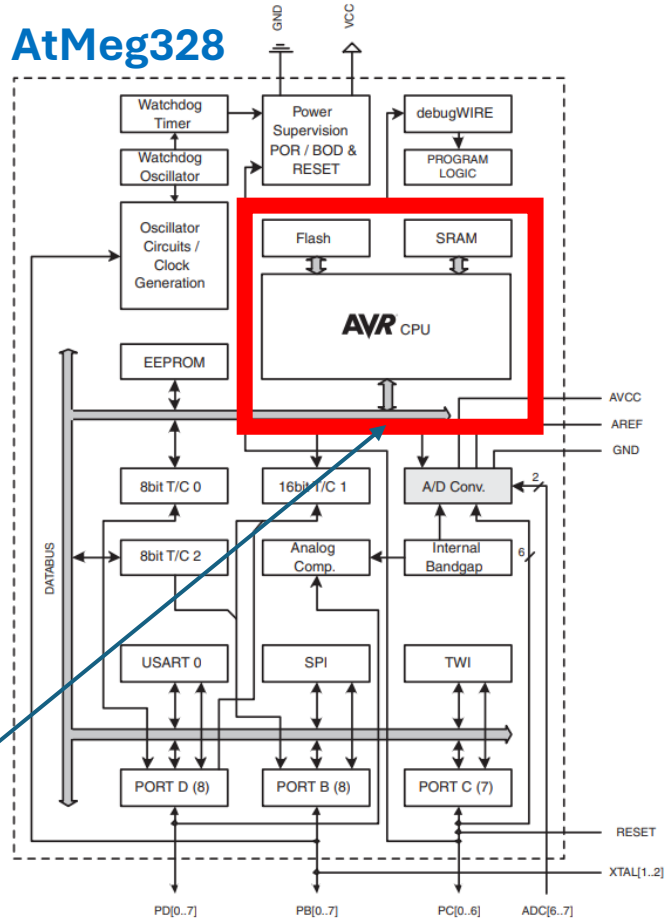




Arduino Nano Dev Kit

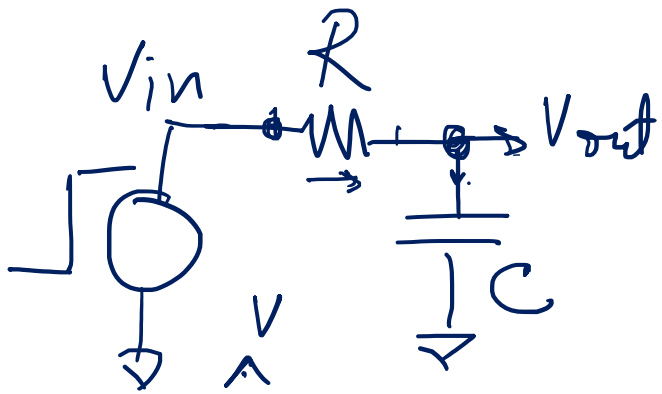


AtMeg328



Microprocessor

Differentiator: WiFi & BLE



$V_{out} = f(V_{in}, t)$?

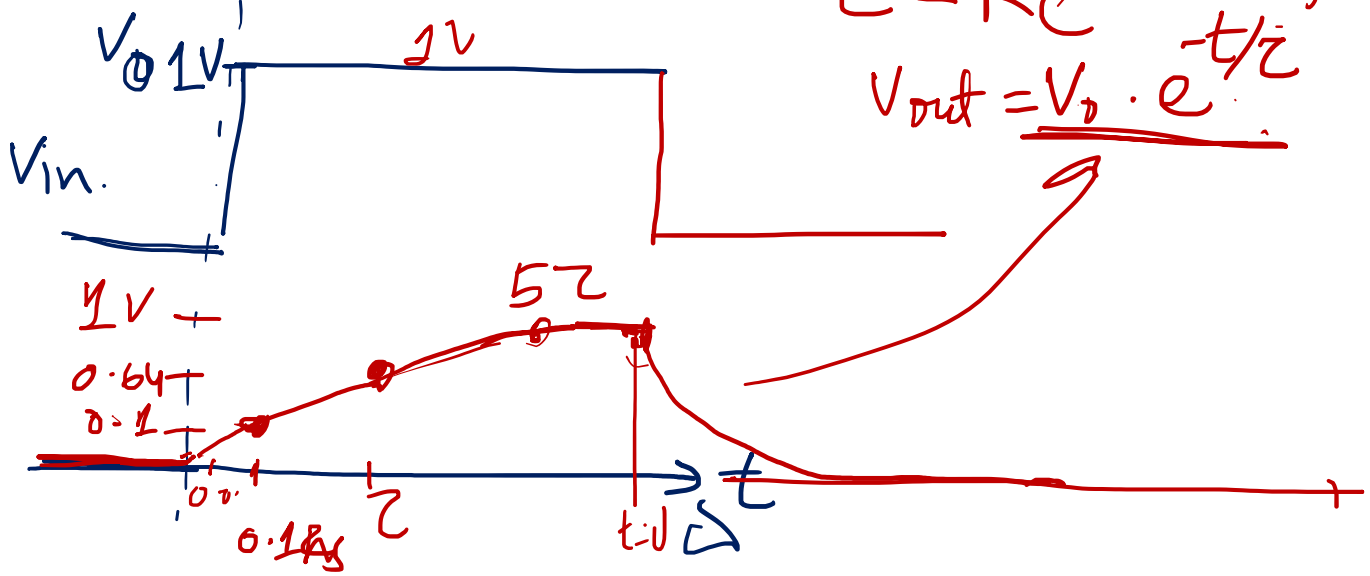
$V_{out} = V_0 (1 - e^{-t/\tau})$ unit

$\tau = RC$

$V_{out} = V_0 \cdot e^{-t/\tau}$

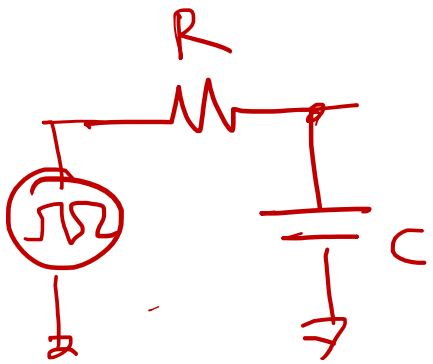
x	e^{-x}	$1 - e^{-x}$
0.01	0.99	0.01
0.1	0.90	0.1
1	0.36	0.64
10	4.5×10^{-5}	1
100		

$e^{-t/\tau}\,(t=0) = 1$



$t=0,\ t=0.01\tau,\ 0.1\tau$

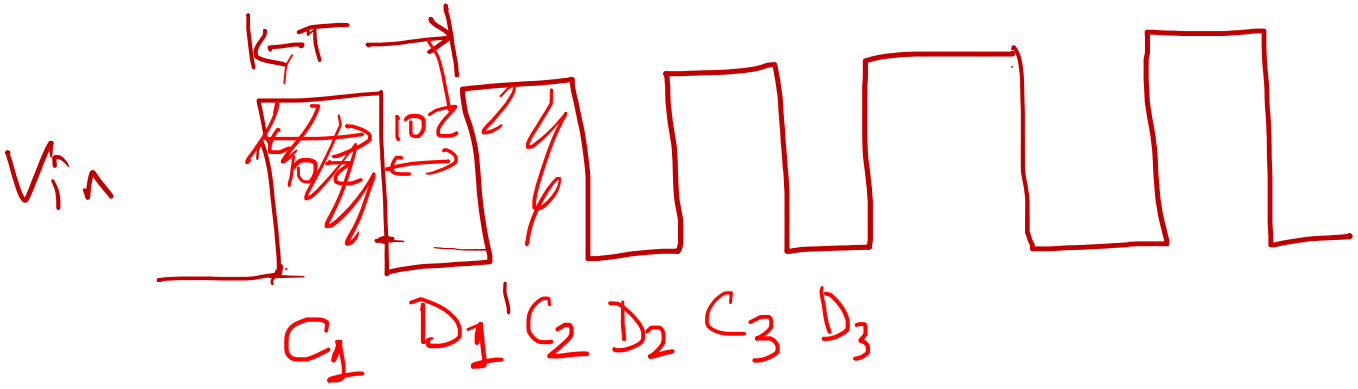
$1k\Omega, 1pF$; $\tau = 1ns$



$T \ll \tau$

$\tau = 20T$

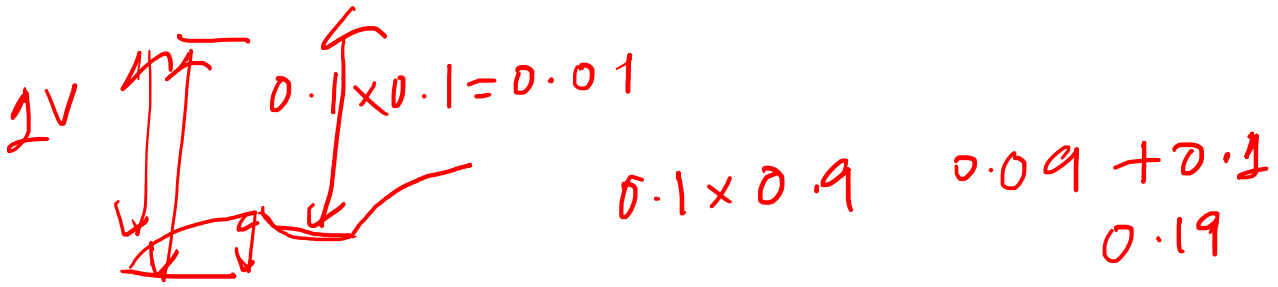
$\tau = RC$



C_1 D_1 C_2 D_2 C_3 D_3

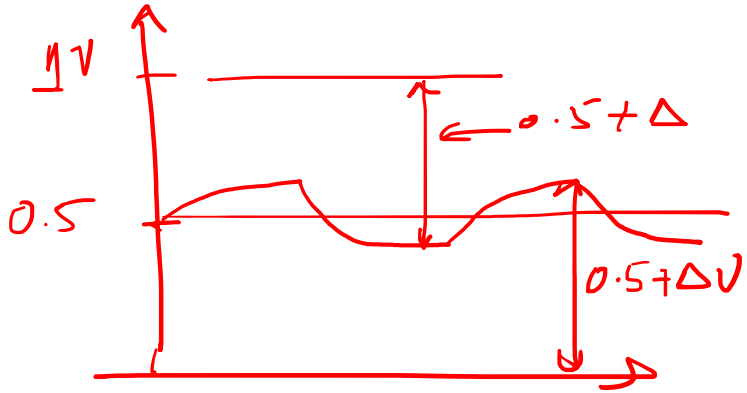
	$V_{out}(V)$
C_1	0.1
D_1	0.09
C_2	0.19
D_2	0.9×0.19 0.18
C_3	
D_3	

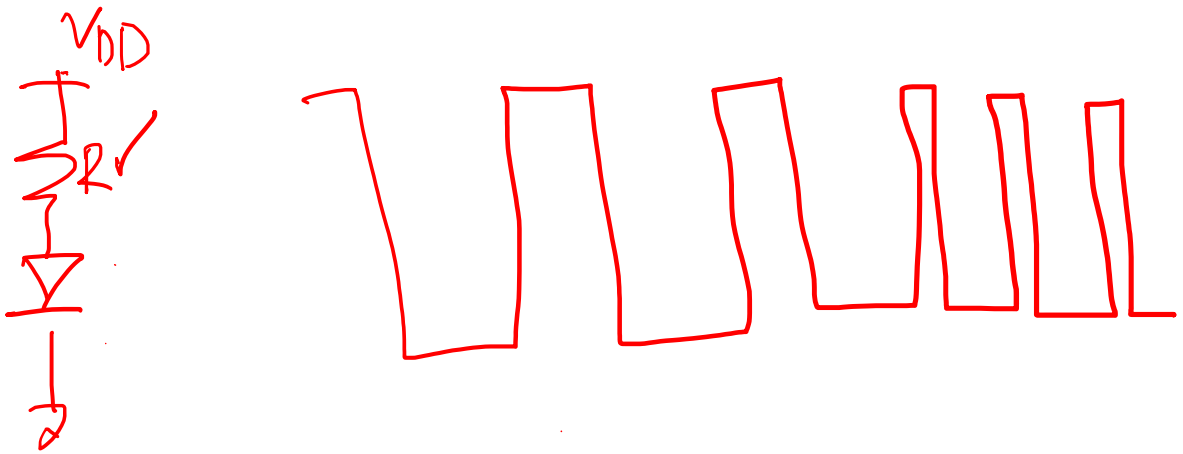
$V_{out} \simeq ?$

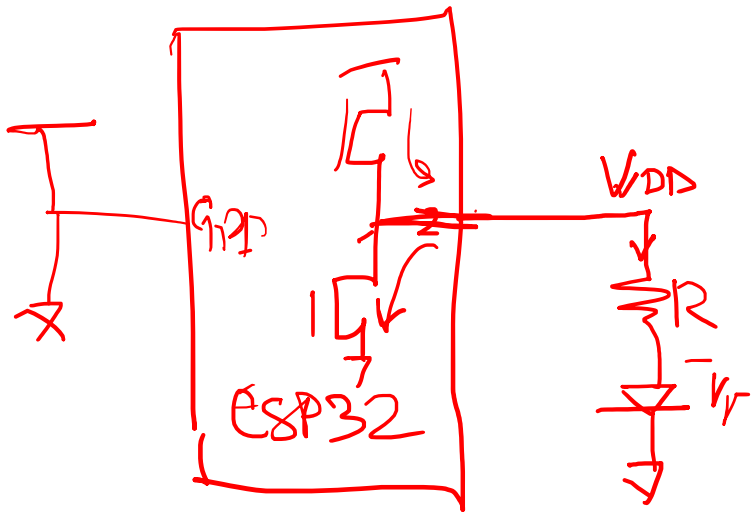


0.1×0.9 $0.09 + 0.1$

0.19







I_{max}

1.5