Internet of Things Master Class Day 2

M.K.Jeevarajan
www.pantechsolutions.net

What you will learn Today

- ✓ How to Choose the Right Embedded processor for IoT
- ✓ Overview of IoT Communication Protocols

Mindset Lesson for the Day

- Dream Big, Set Your Goals high.
- List down 20 Answers How you Achieve the Goal.
- Take Action.
- You need a Strong Why .Without a Burning Desire you cannot achieve the Goal.

How to choose the right processor for IoT and IoT Communication protocols

Types of Processors and Controllers

Dallas,philips
Renesas,freescale,
Texas,Microchip

Microproce
Microcontrollers (8/16/32)

Texas,analog
devices,Motorolla,

SOC

QUALCOMM
BROADCOMM

CPLD/FPGA

Xilinx,Altera
Lattice,Actel

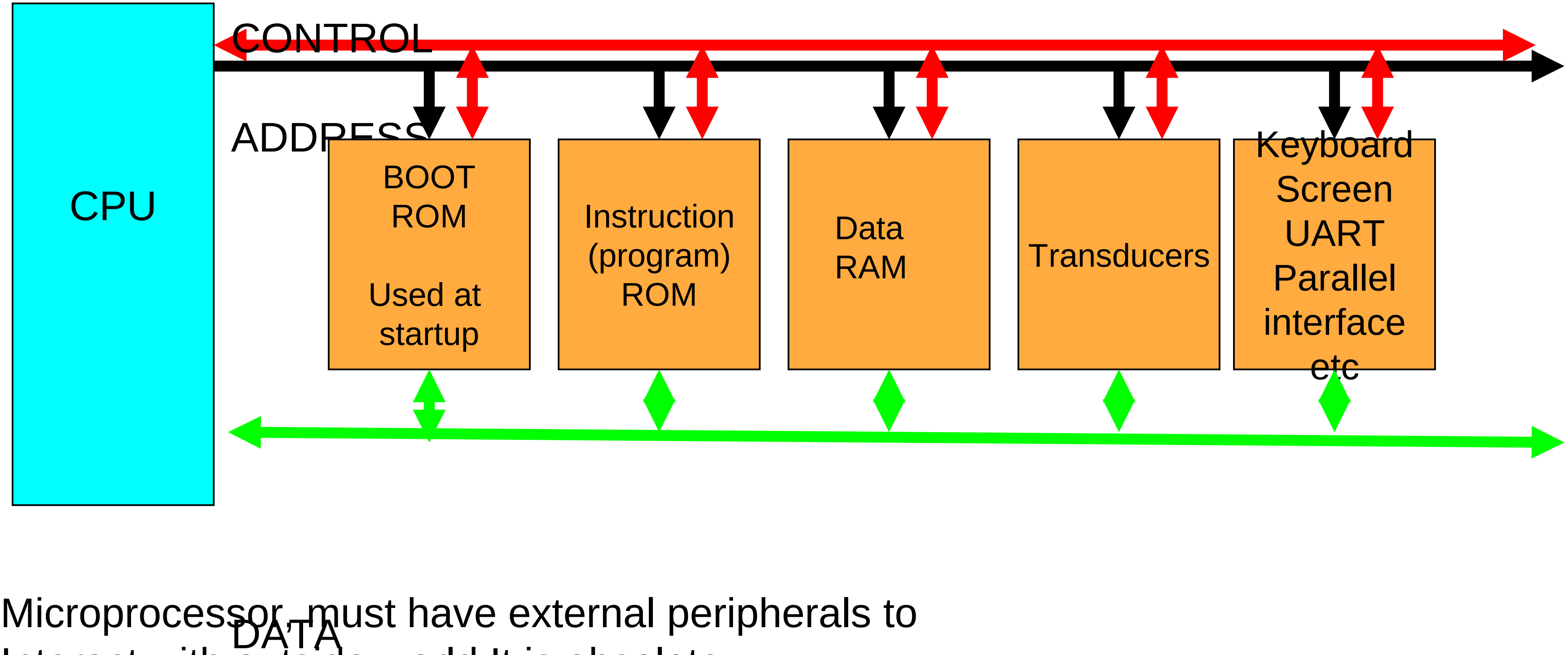
GENERAL PURPOSE
PROCESSORS
(CPU Vs GPU)

Intel,AMD,Nvidia

ASIC

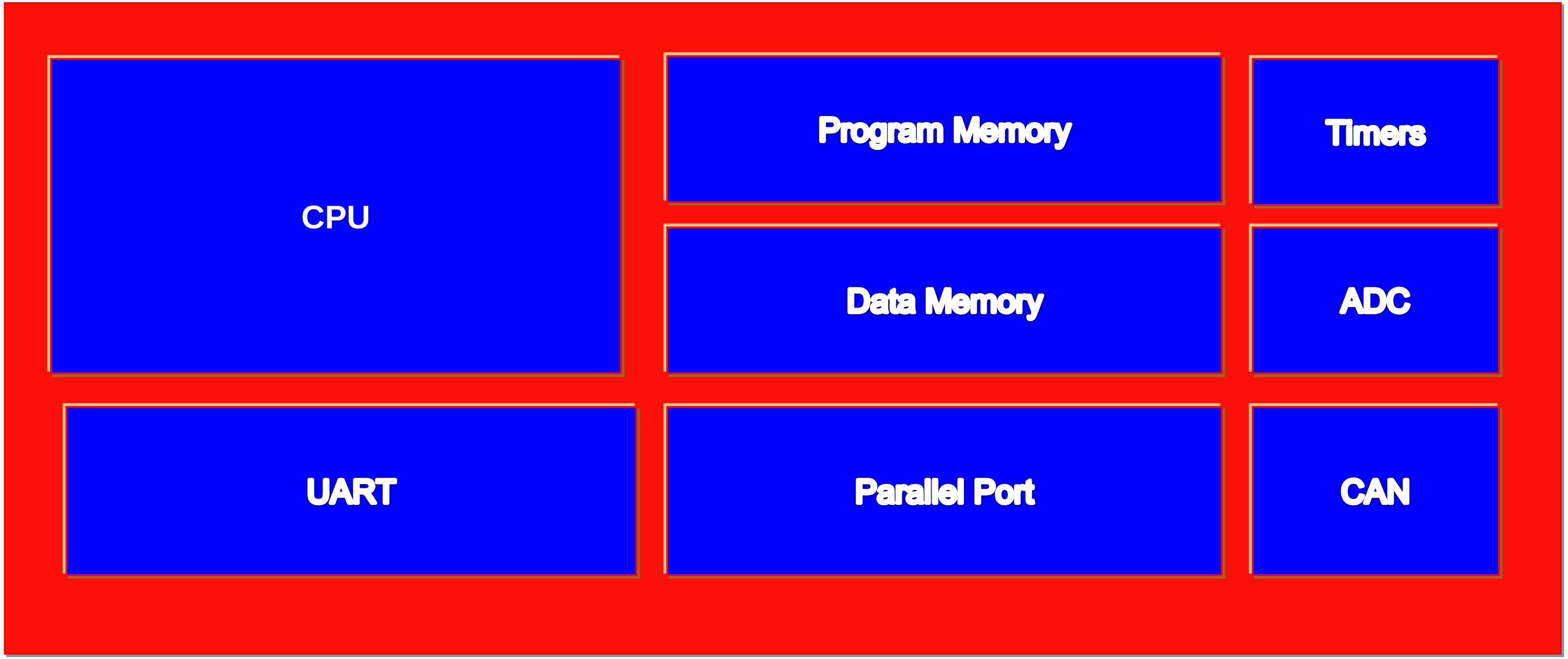
INTEL

Microprocessor Basic



Microprocessor, must have external peripherals to
Interact with outside world,It is obsolete

Micro controller

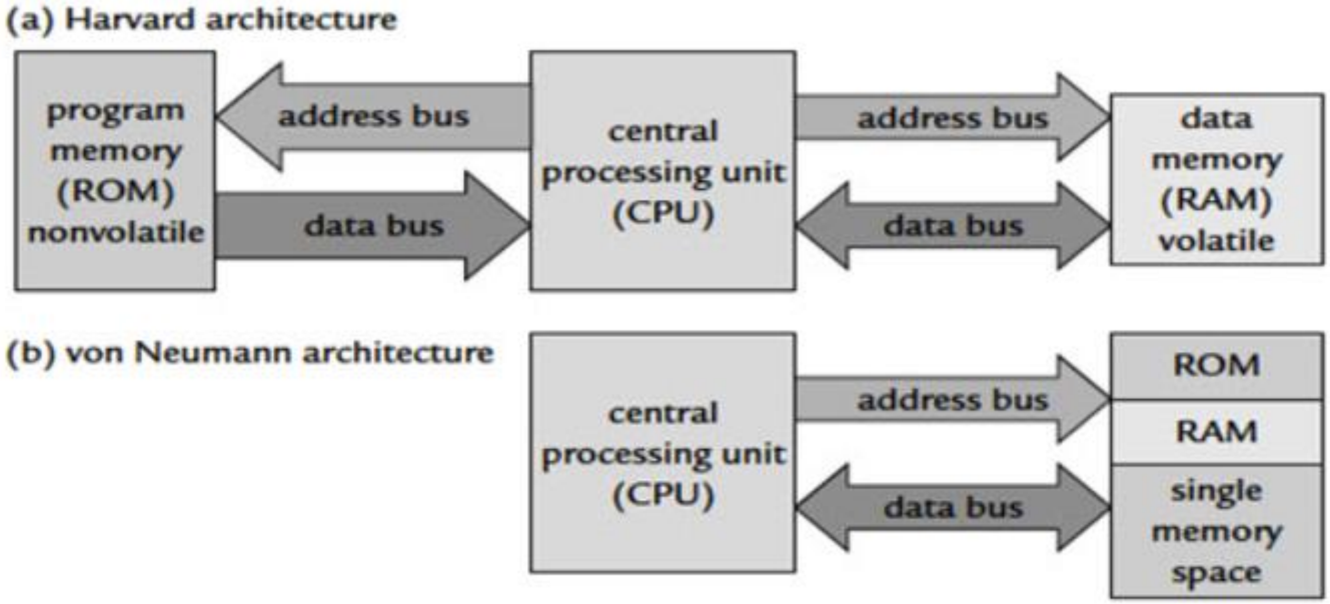


Basic Features of DSPs

- ✓Digital Signal Processor is **mathematics on chip**.
- ✓ DSPs usually run applications with **hard real-time** constraints:
- ✓ DSPs usually process **infinite continuous data streams**.
- ✓MAC Capability
- ✓DSP processors are microprocessors designed for efficient mathematical manipulation of digital signals.

Why do we need DSP processors?

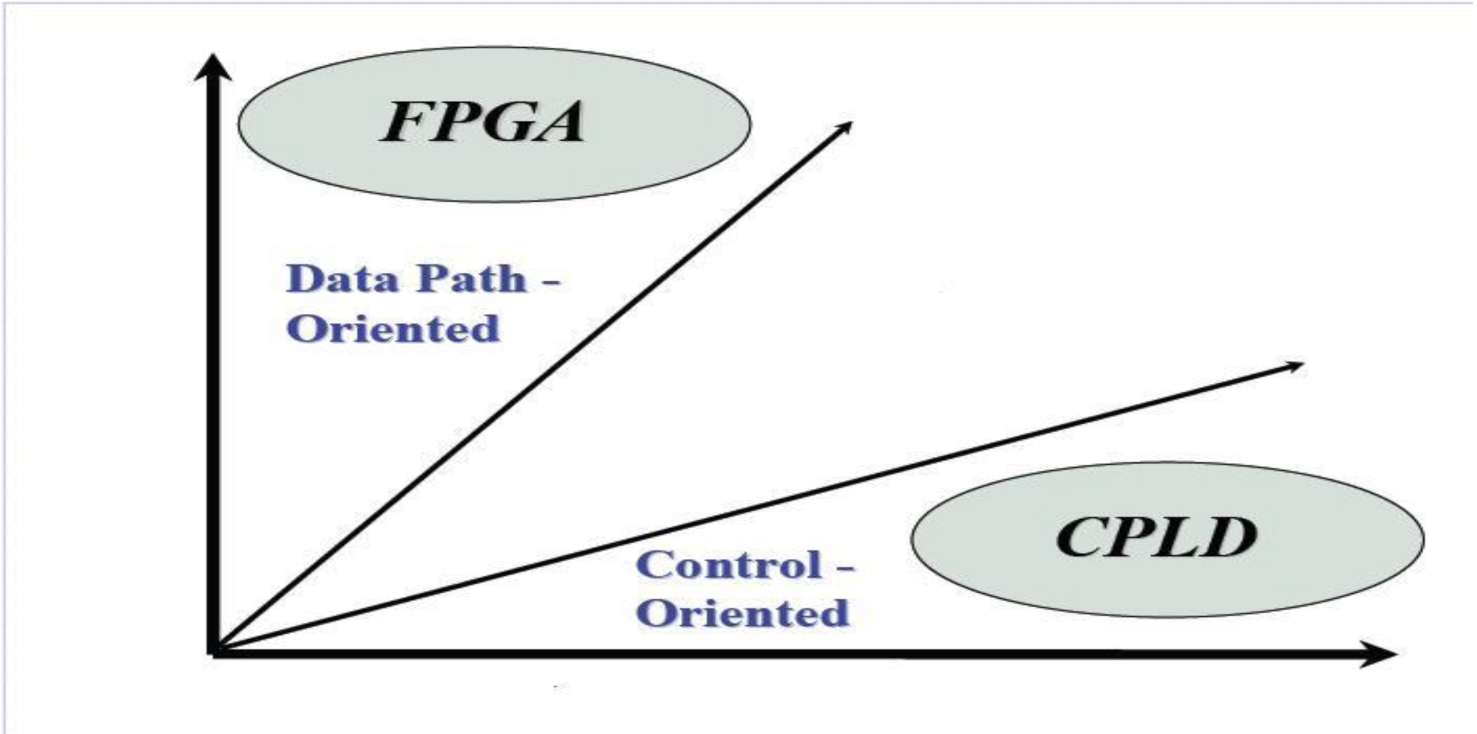
- Micr
- Use c
  -
  -
- Use c



Von Neuman and Harvard Architectures for Memory

  - Processing of signals in real-time.

CPLD Vs FPGA

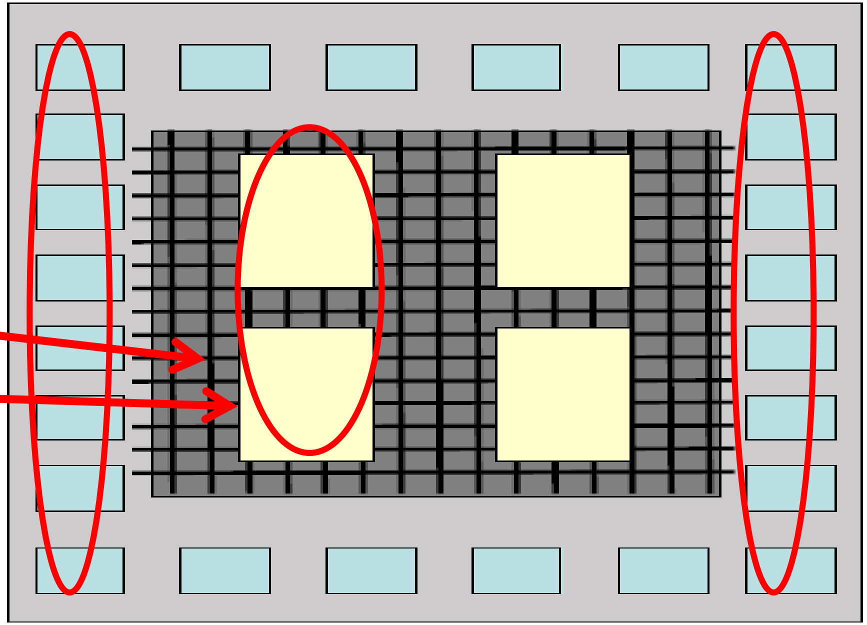


Diff between PLA,PAL,PLD,CPLD and FPGA

- ❑ ***PLA*** — a Programmable Logic Array (PLA) is a relatively small FPD that contains two levels of logic, an AND-plane and an OR-plane, where both levels are programmable
- ❑ ***PAL*** — a Programmable Array Logic (PAL) is a relatively small FPD that has a programmable AND-plane followed by a fixed OR-plane
- ❑ ***SPLD*** — refers to any type of Simple PLD, usually either a PLA or PAL
- ❑ ***CPLD*** — a more Complex PLD that consists of an arrangement of multiple SPLD-like blocks on a single chip.
- ❑ ***FPGA*** — a Field-Programmable Gate Array is an FPD featuring a general structure that allows very high logic capacity.

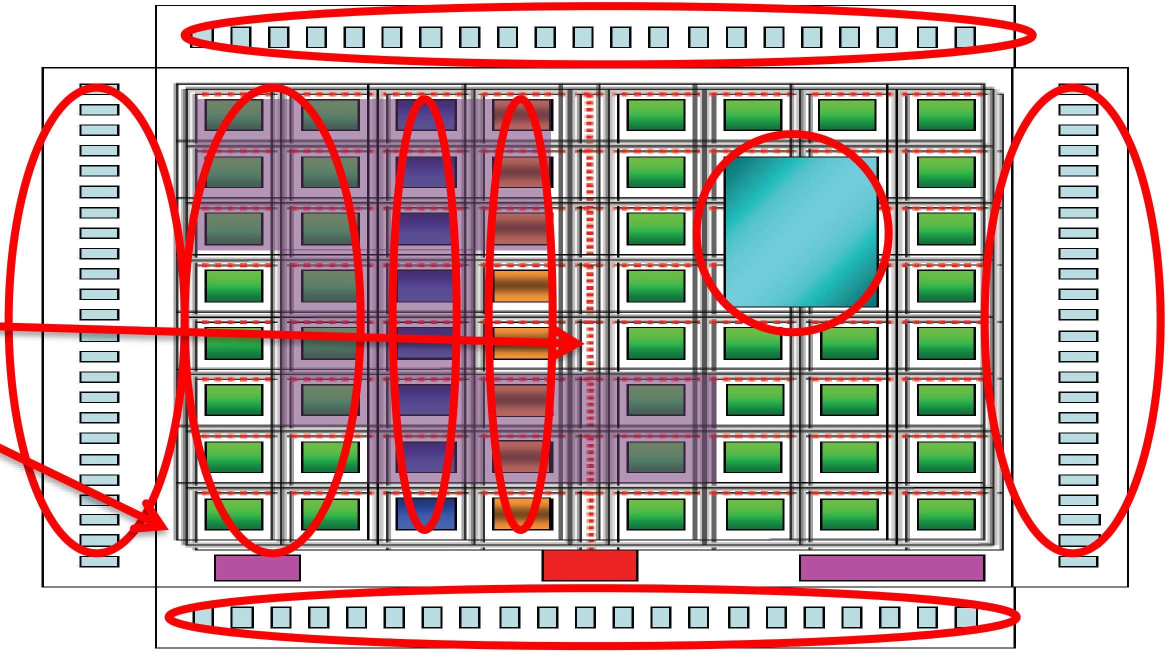
CPLD Architecture

- ✓Logic blocks
- ✓ I/O blocks
- ✓Clock routing
- ✓Routing matrix

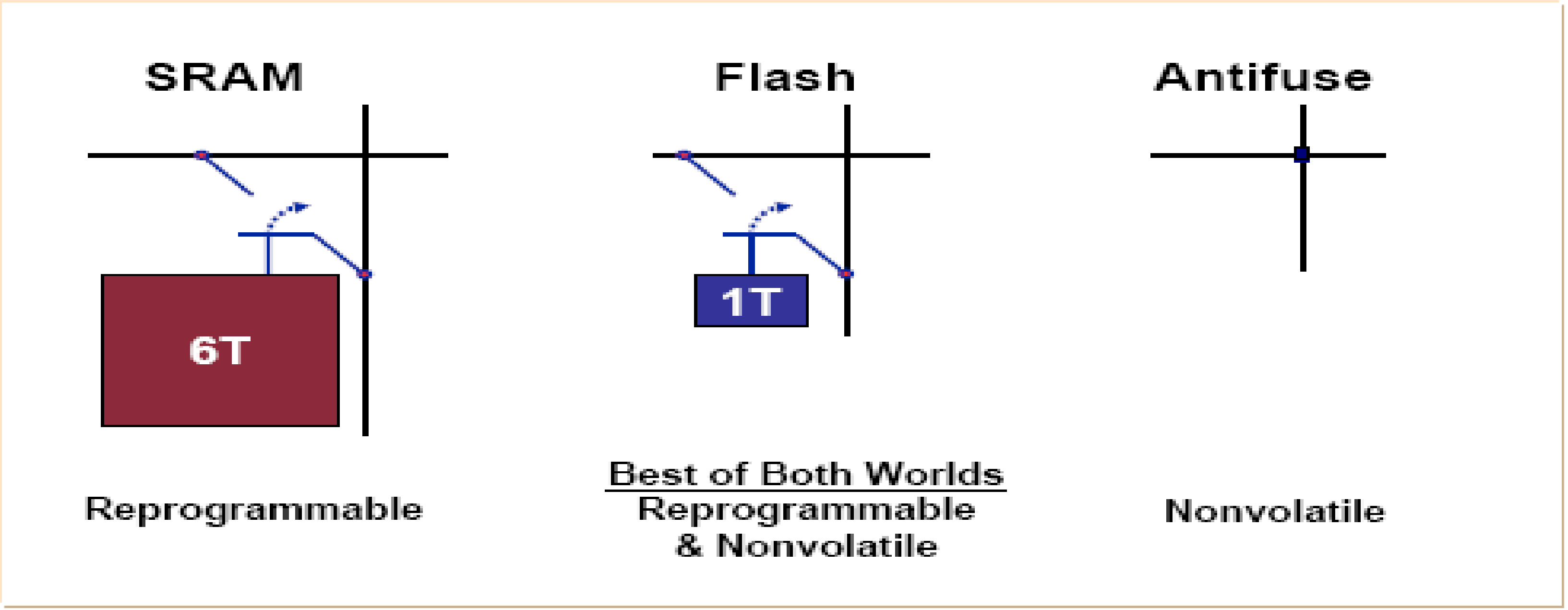


FPGA Architecture

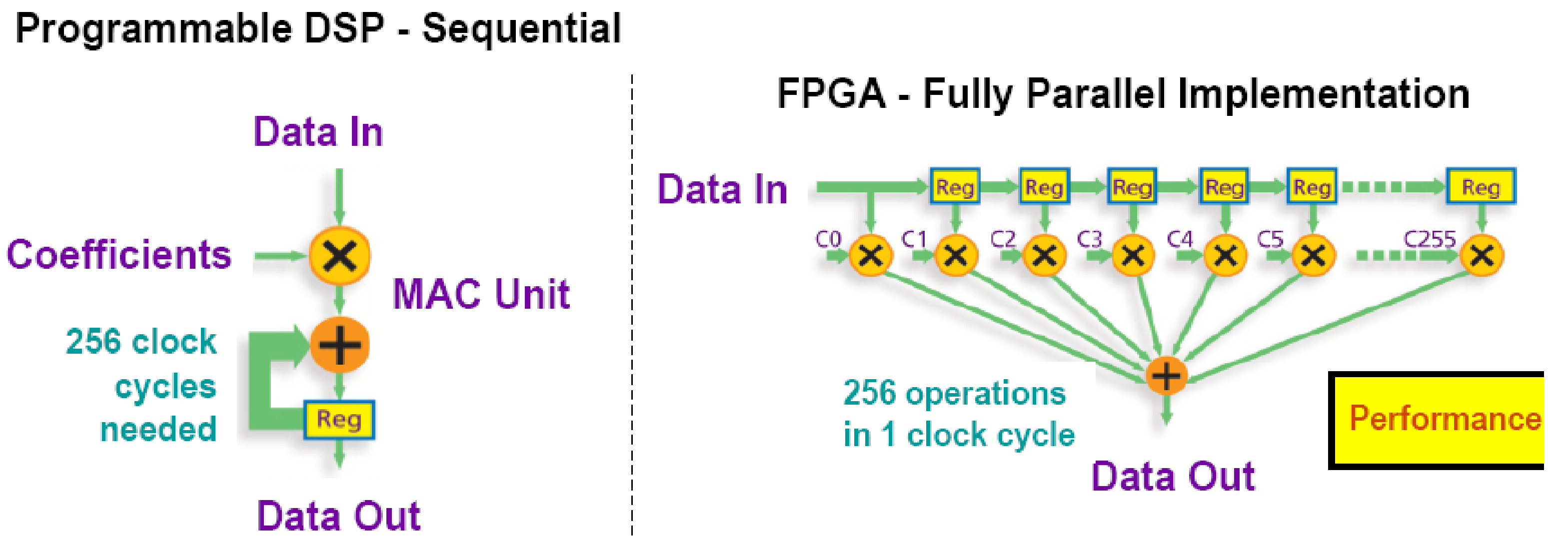
- ✓Logic blocks
- ✓I/O blocks
- ✓Clock routing
- ✓Routing matrix
- ✓Memory
- ✓Multipliers /DSP blocks
- ✓Processor core



FPGA Technologies



DSP Vs FPGA

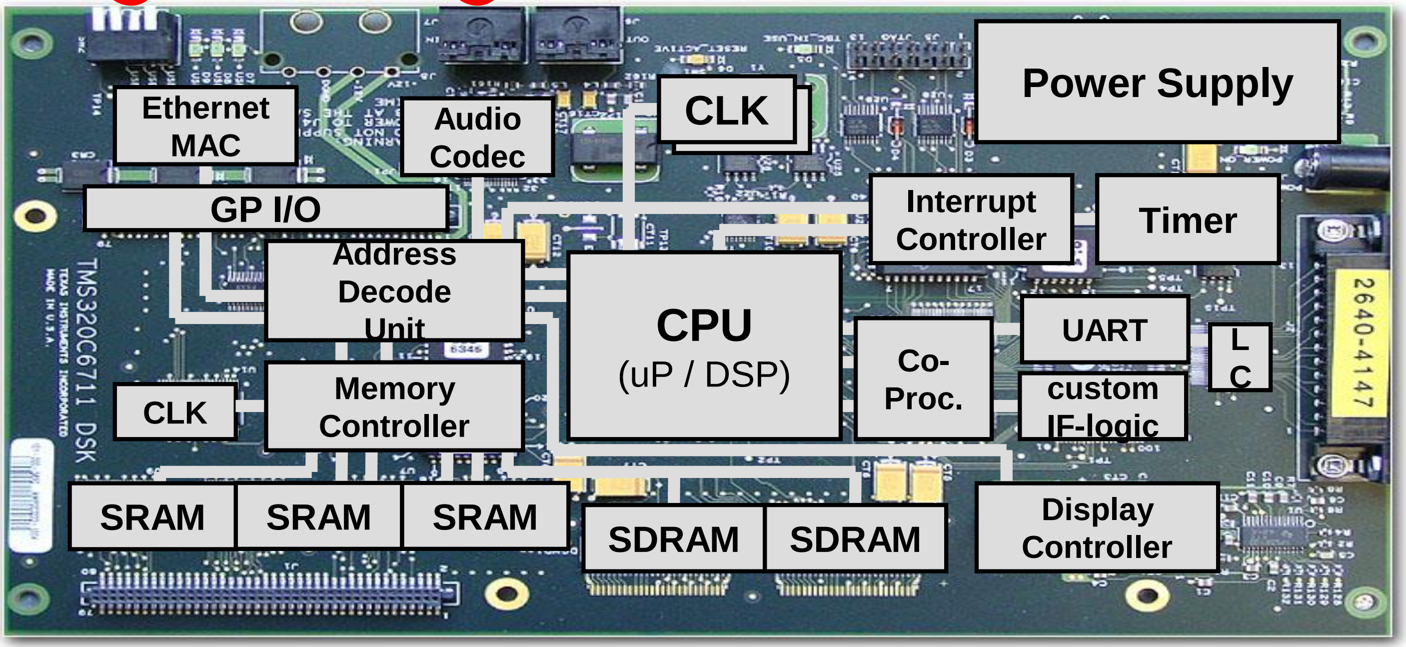


Programmable DSP - Sequential
Data In
Coefficients
MAC Unit
256 clock cycles needed
Reg
Data Out
FPGA - Fully Parallel Implementation
Data In
Reg
C0
C1
C2
C3
C4
C5
C255
256 operations in 1 clock cycle
Data Out
Performance

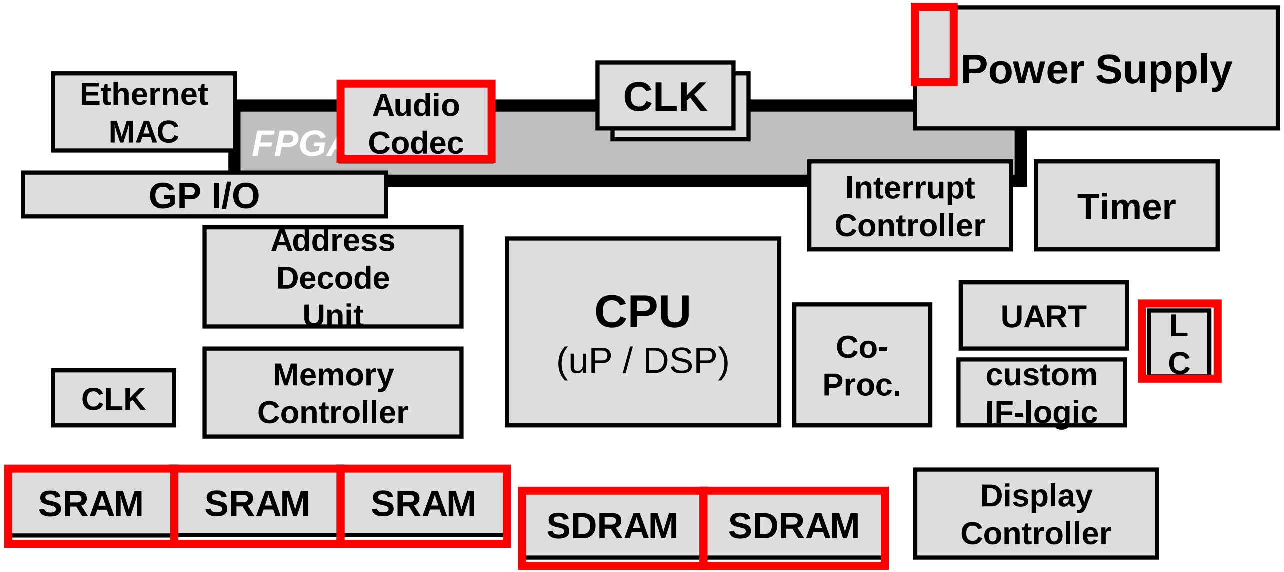
When to use DSP in FPGA

- ✓ **Higher Performance**
  - Parallel algorithm implementation
- ✓ **Customizable Design**
  - Optimize for speed and cost
- ✓ **System Integration**
  - Less board real estate
  - Less chips could mean less system cost

Traditional embedded system design using DSP

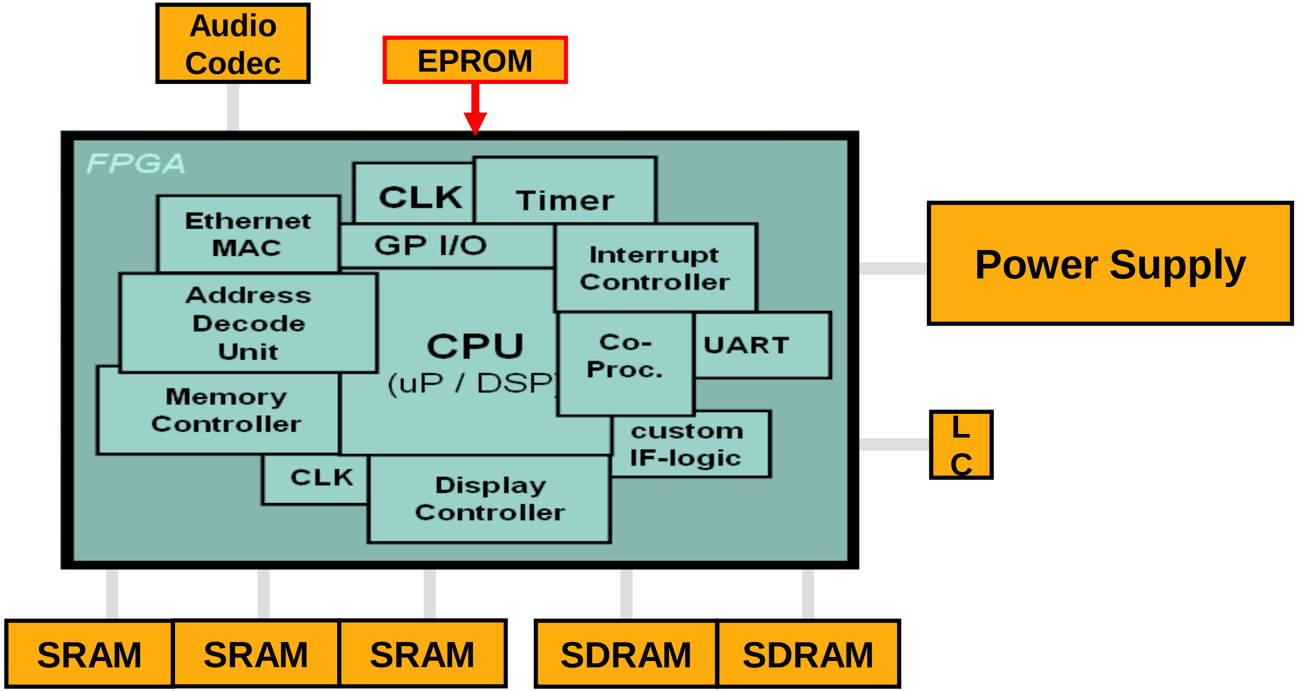


Next Step...



Ethernet MAC
FPGA
Audio Codec
CLK
Power Supply
GP I/O
Interrupt Controller
Timer
Address Decode Unit
CPU (uP / DSP)
Co-Proc.
UART
L C
custom IF-logic
CLK
Memory Controller
SRAM
SRAM
SRAM
SDRAM
SDRAM
Display Controller

Configurable system on Chip- CSoC



Multicore Processor -SoC

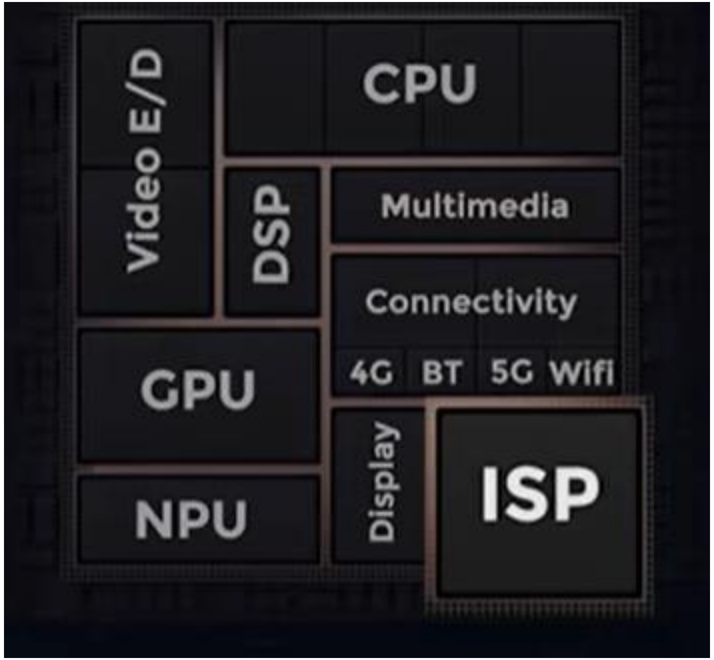
2 or More Independent Processors in 1 Package

Symmetric Multiprocessing

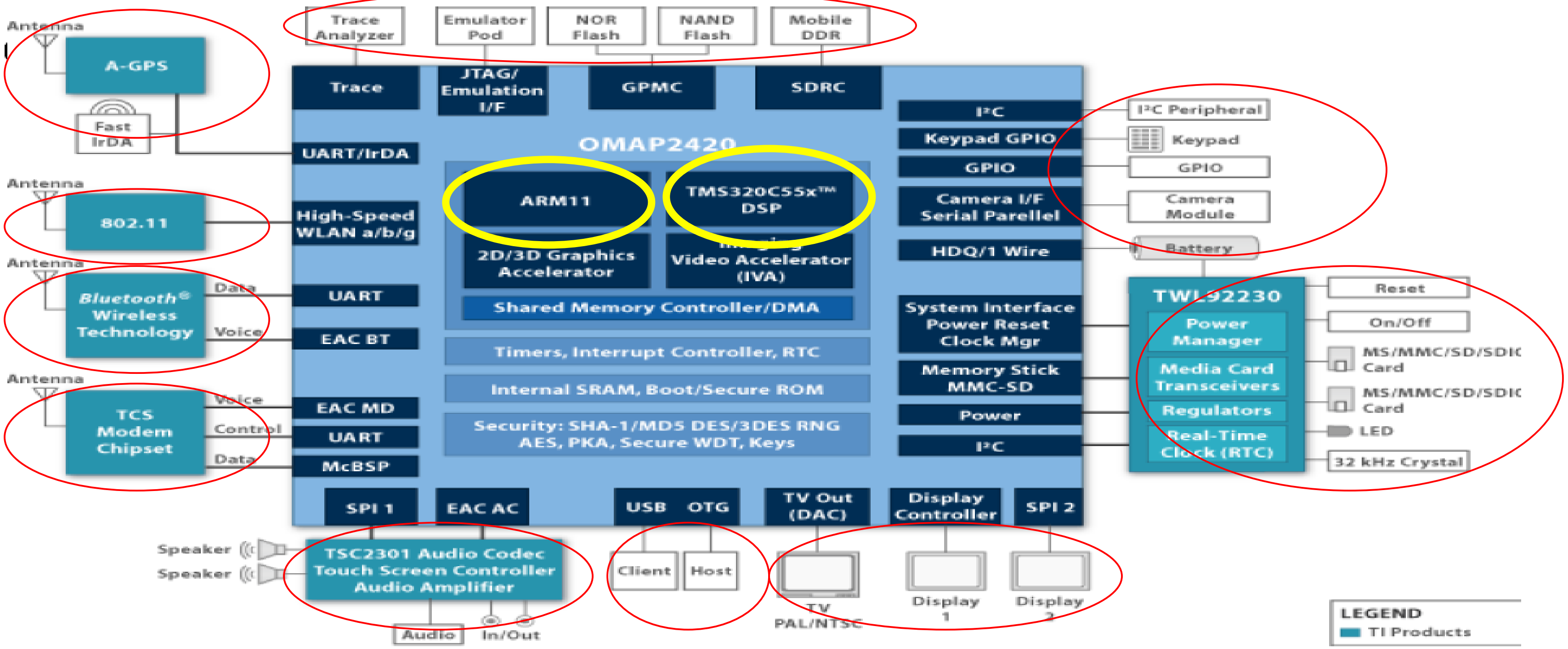
- ✓ Number of Identical Processors
- ✓ Common Shared Memory
- ✓ One Operating System

Asymmetric Multiprocessing

- ✓ Different Processors, Instruction Sets
- ✓ Different Operating Systems
- ✓ Possibly Without Shared Memory



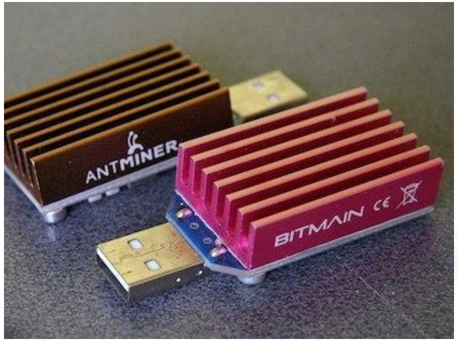
AMP-TI OMAP



- ➢Processors Need Not be Identical
- ➢Processor Specialization May Increase Performance.
- ➢T.I.'s OMAP•General Purpose Processor+Digital Signal Processor("DSP")

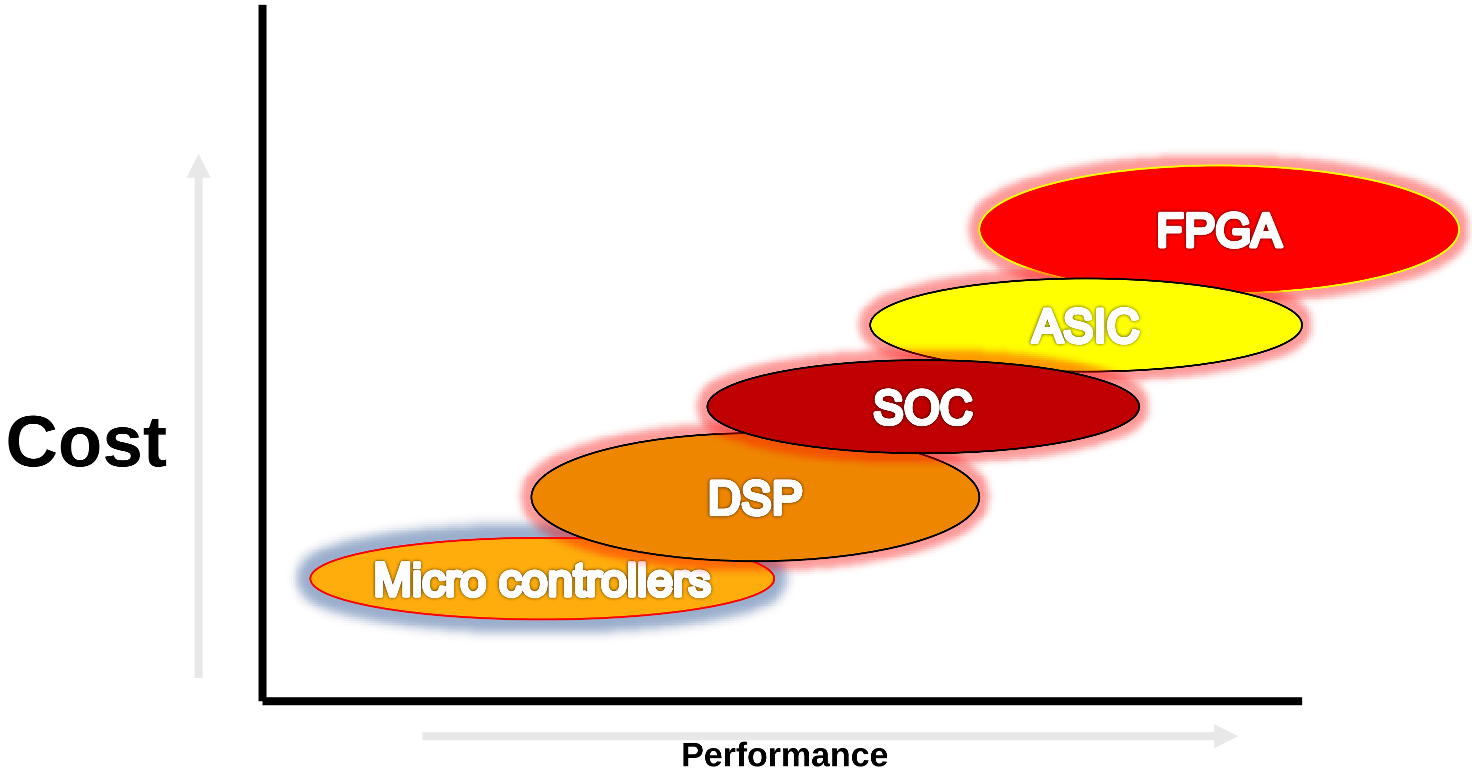
How FPGA Is Different From ASICs

- ASIC (Application-Specific Integrated Circuit)
    - Special chip purpose-built for an application
    - E.g., ASIC bitcoin miner, Intel neural network accelerator
    - Function cannot be changed once expensively built



- + FPGAs can be *field-programmed*
    - Function can be changed completely whenever
    - FPGA fabric *emulates* custom circuits

Comparison



Cryptographic Enabled Processors

CEC1702

- Full-featured ARM® Cortex®-M4-based microcontroller
- This low-power but powerful, programmable 32-bit microcontroller protects secrets with encryption and validates firmware has been digitally signed and untouched using public key cryptography.

Public Key Crypto Engine

The Public Key Crypto Engine is a versatile IP core for hardware offloading of all asymmetric cryptographic operations. It enables any FPGA to support efficient execution of RSA, ECC-based algorithms

- ✓ MPU/MCU Crypto acceleration
- ✓ Hardware Security Module (HSM): Car-to-X, Banking, Government, Enterprise VPN
- ✓ Industrial communications
- ✓ Networking security: TLS/SSL IPsec, Diffie-Hellman

Processor selection Criteria

- ✓ Development tools
- ✓ Number of I/O's
- ✓ Performance
- ✓ Cost
- ✓ Operating systems
- ✓ Hardware tools
- ✓ Peripherals
- ✓ Power consumption
- ✓ Supplier reputation

Top 8 IoT Communication Protocols

- **ZigBee**
- **LoRa/LoRaWAN**
- BLE
- Wi-Fi
- Cellular
- Z-wAVE
- MQTT-Message Queuing and Telemetry Transport
- AMQP-Advanced Message Queuing Protocol
- **LWM2M-** Lightweight M2M (LWM2M)

Bluetooth & BLE

- The frequency range supported in Bluetooth vary from **2.4 GHz to 2.483 GHz**. It covers less distance than Zigbee.
- Bluetooth is a wireless technology standard created for Short range
- Ideal for Speakers, Printers which could communicate in short distance
- Bluetooth Low Energy—abbreviated Bluetooth LE—was originally branded as “Bluetooth 4.0” when it was created in 2011. Its primary benefit (and the difference from “regular” Bluetooth) is its low power consumption. Ideal for IoT
- Bluetooth is supported by Bluetooth SIG

ZigBee

- ZigBee is a mesh network protocol designed to carry small amounts of data across medium distances.
- Zigbee was designed for building and home automation applications, and it's one of the most popular mesh protocols in IoT environments.
- A short-range and low-power protocol, Zigbee can be used to extend communication over multiple devices.
- It has a longer range than BLE, but it has a lower data rate than BLE.

Z-Wave

- Another proprietary option, Z-Wave is a wireless mesh network communication protocol built on low-power radio frequency technology. Like Bluetooth and Wi-Fi, Z-Wave lets smart devices communicate with encryption, thereby providing a level of security to the IoT deployment.
- It's commonly used for home automation products and security systems, as well as in commercial applications such as energy management technologies.
- It operates on 908.42 MHz radio frequency in the U.S.; although, its frequencies vary country by country.
- Z-Wave is supported by the Z-Wave Alliance,

LoraWAN

- LoRa, for long range, is a noncellular wireless technology that, as its name describes, offers long-range communication capabilities. It's low power with secure data transmission for M2M applications and IoT deployments. A proprietary technology, it's now part of Semtech's radio frequency platform.
- LoRaWAN is an open protocol that enables **IoT devices** to use LoRa for communication.

Cellular

- Cellular is one of the most widely communications range over longer distances.
- Although 2G and 3G legacy cellular standards are now being phased out, telecommunications companies are rapidly expanding the reach of newer high-speed standards -- namely 4G/LTE and 5G.
- Cellular provides high bandwidth and reliable communication.
- It's capable of sending high quantities of data, which is an important capability for many IoT deployments.
- However, those features come at a price, higher cost and power consumption than other options

MQTT- Message Queuing Telemetry Transport

- Developed in 1999 and first known as Message Queuing Telemetry Transport, it's now just MQTT. There is no longer any message queueing in this protocol. MQTT uses a publish-subscribe architecture to enable M2M communication
- Its simple messaging protocol works with constrained devices and enables communication between multiple devices.
- It was designed to work in low-bandwidth situations, such as for sensors and mobile devices on unreliable networks.

AMQP-Advanced Message Queuing Protocol

- AMQP is an open standard protocol used for more message-oriented middleware. As such, it allows for messaging interoperability between systems regardless of the message brokers or platforms being used.
- It offers security and interoperability, as well as reliability, even at a distance or over poor networks.
- It supports communications, even when systems aren't simultaneously available.

LWM2M- Lightweight M2M (LWM2M)

- Lightweight M2M (LWM2M) as "a device management protocol designed for sensor networks and the demands of an M2M environment."
- This communication protocol was designed specifically for remote device management and telemetry in IoT environments and other M2M applications
- it's a good option for low-power devices with limited processing and storage capabilities.

CoAP- Constrained Application Protocol

- The IETF Constrained RESTful Environments working group in 2013 launched CoAP, for Constrained Application Protocol, having designed it to work with HTTP-based IoT systems.
- CoAP relies on the User Datagram Protocol to establish secure communications and enable data transmission between multiple points. Often used for machine-to-machine (M2M) applications
- CoAP enables constrained devices to join an IoT environment, even with the presence of low bandwidth, low availability and/or low-energy devices.

Thank you