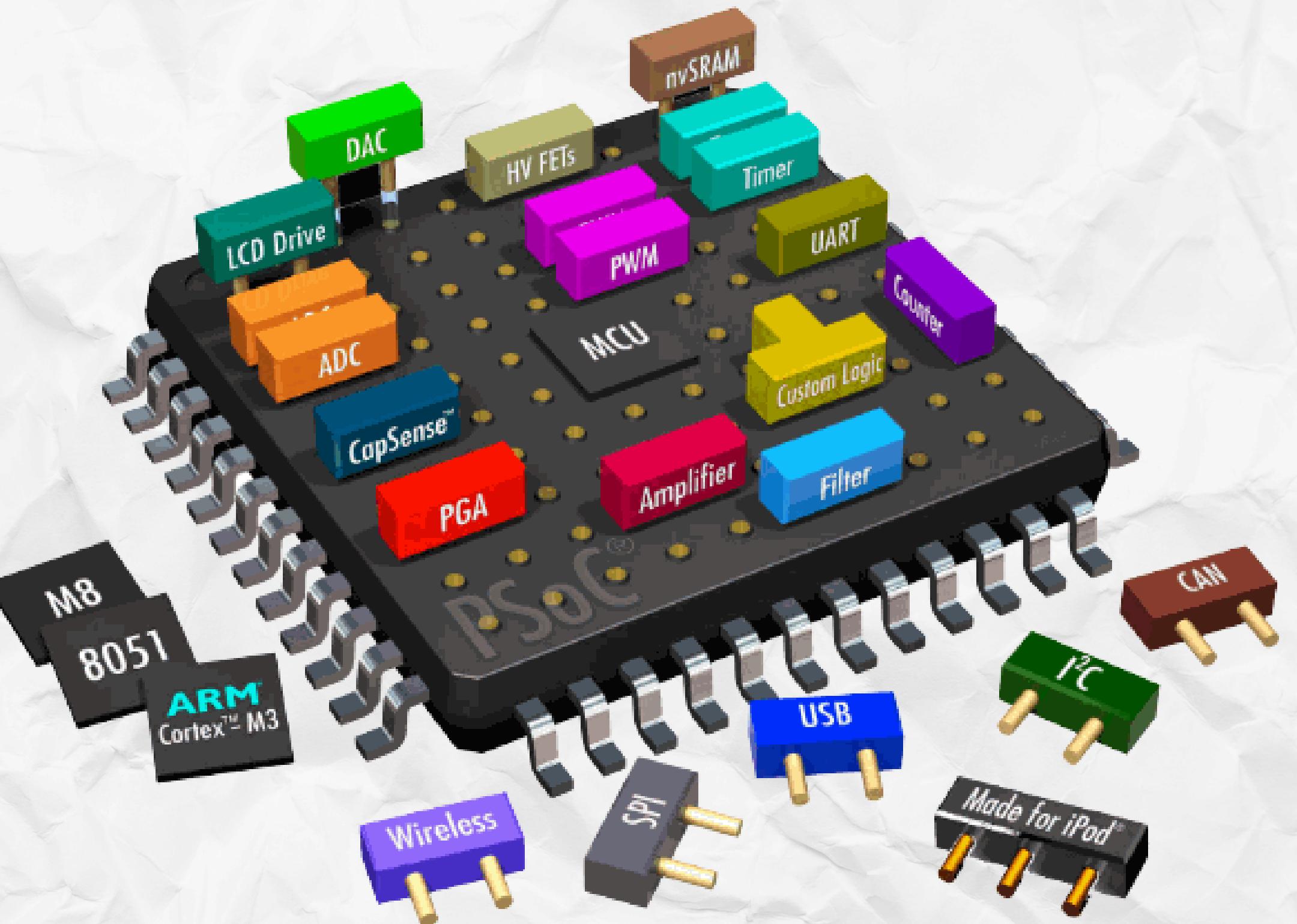


SoC

System On Chip



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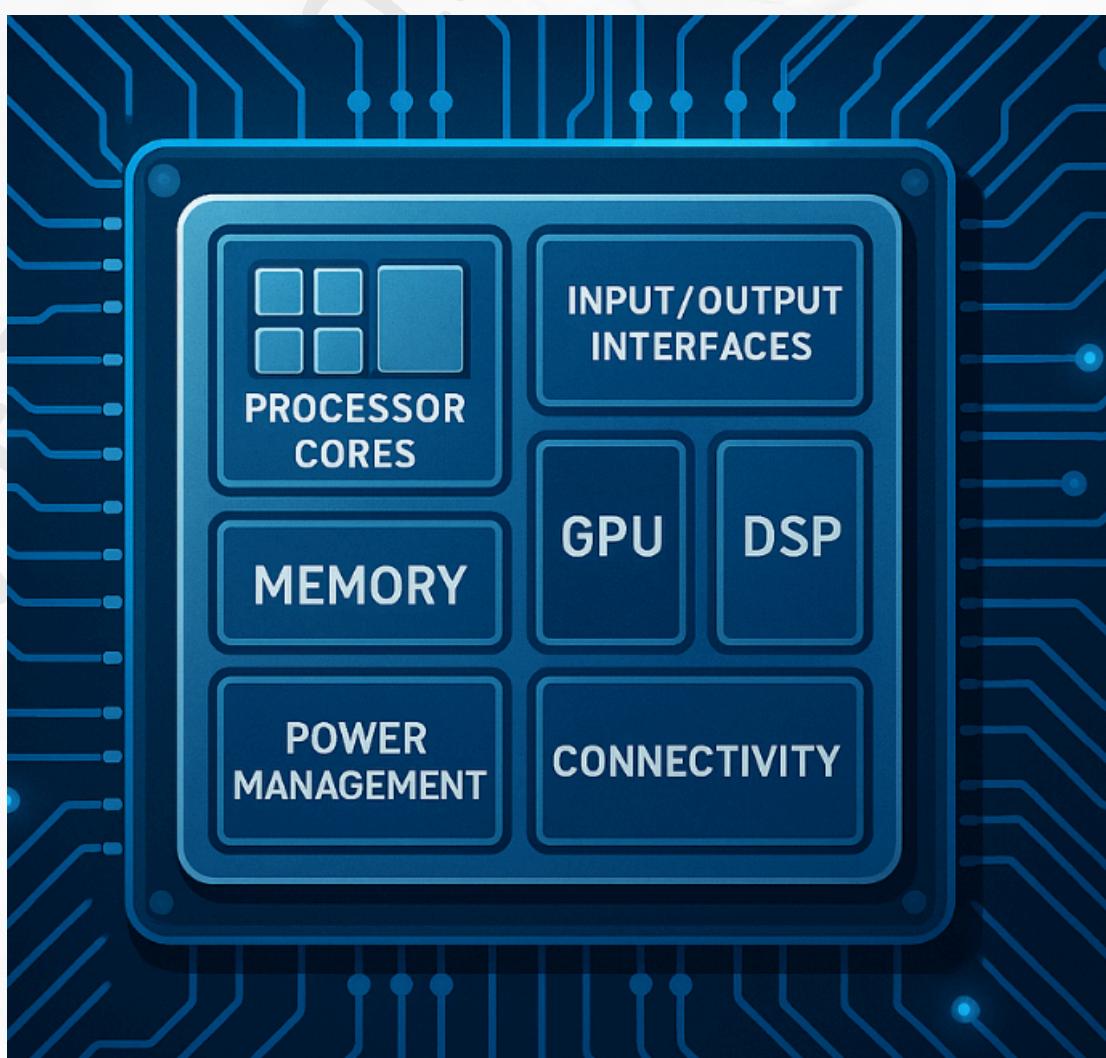


What is SoC?

A System on Chip (SoC) is a highly integrated circuit that combines most or all essential components of a computer or electronic system onto a single microchip.

Key Components:

- Central Processing Unit (CPU)
- Memory (RAM, ROM, cache)
- Input/Output (I/O) ports
- Secondary storage controllers



Processor / SoC (System on Chip)

The heart of the ECU, responsible for all computing.

Modern ADAS ECUs use heterogeneous SoCs that combine:

- CPU cores (for control logic)
- GPU cores (for vision-based processing)
- DSPs (for signal processing)
- NPU/AI cores (for object detection & classification)

Examples:

- NVIDIA Xavier / Orin
- Renesas R-Car Series
- TI Jacinto TDA4x
- Mobileye EyeQ
- Qualcomm Snapdragon Ride

These SoCs may support hardware virtualization and **ASIL-D** safety partitions.



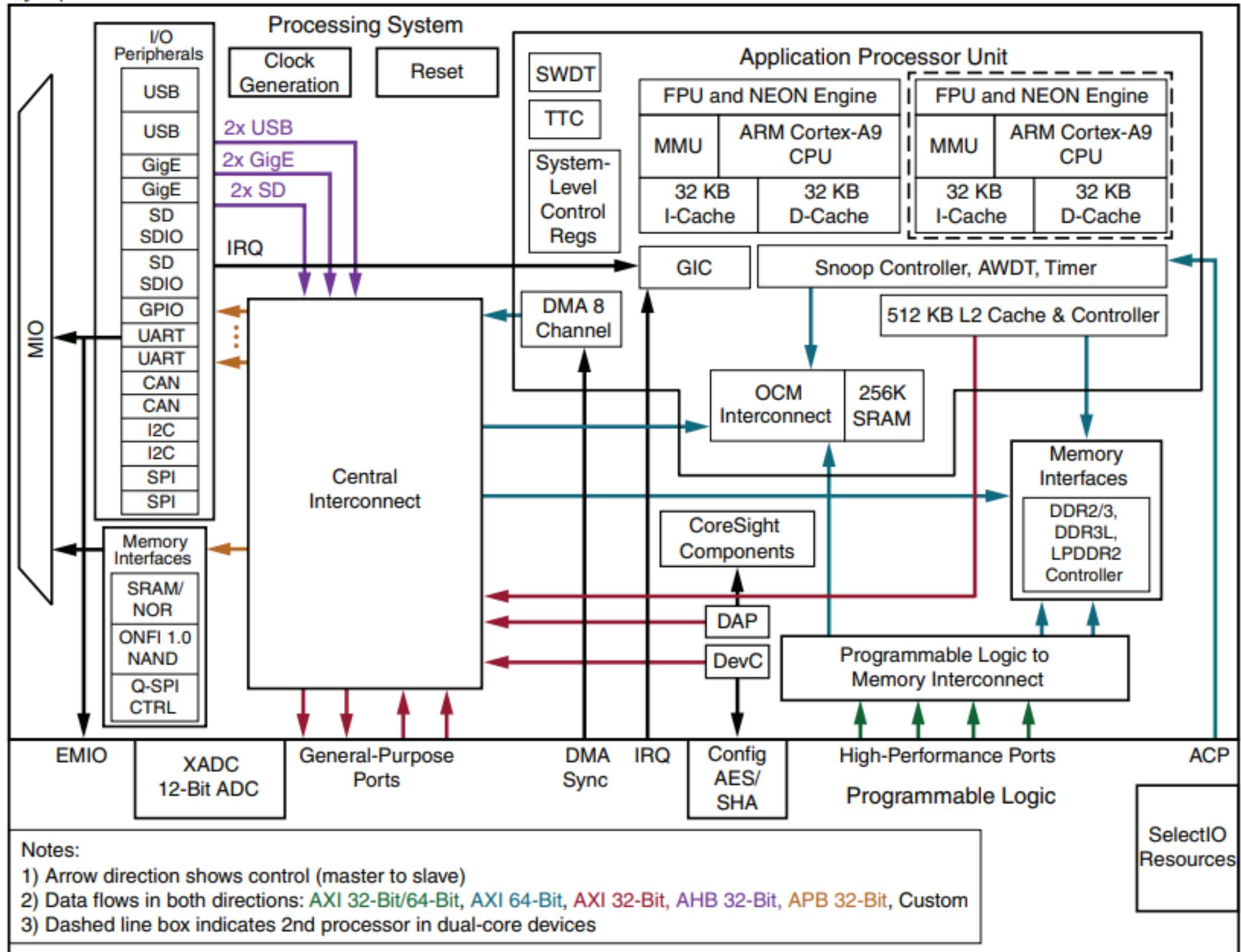
Why is SoC

- **Space** Efficiency – Small is Smart
- **Power** Efficiency – Longer Battery Life
- **Cost** Efficiency – One Chip, Many Functions
- **Performance** – Speed Through Integration
- Customization for Specific Applications



Zynq-7000 SoC Architecture

Zynq-7000 SoC



Types of SoC Architectures

Single-Core vs. Multi-Core SoCs

- **Single-Core SoCs:** Feature one processor core, suitable for simple or low-power applications.
- **Multi-Core SoCs:** Incorporate multiple cores, enabling parallel processing and improved multitasking. Multi-core designs are standard in smartphones, tablets, and high-performance embedded systems.

Symmetric vs. Asymmetric Multiprocessing

- **Symmetric Multiprocessing (SMP):** All cores are identical and share the workload equally.
- **Asymmetric Multiprocessing (AMP):** Cores have specialized roles, with some dedicated to real-time processing and others to general-purpose tasks. This is common in automotive and industrial applications.



Peripheral Integration

SoCs integrate a wide range of peripherals, including:

- **Analog-to-Digital Converters (ADC)** and **Digital-to-Analog Converters (DAC)**: For interfacing with sensors and actuators.
- **Timers and Counters**: For time-sensitive operations.
- **Communication Modules**: UART, SPI, I2C, and others for serial communication.
- **Multimedia Engines**: Audio and video codecs for media processing.



Applications of SoC Architecture

SoC architecture underpins a vast array of modern technologies:

- **Mobile Devices:** Smartphones, tablets, and wearables rely on SoCs for compactness, efficiency, and powerful features.
- **Automotive Systems:** Advanced driver-assistance systems (ADAS), infotainment, and autonomous driving platforms use SoCs for real-time processing and connectivity.
- **IoT Devices:** Smart home devices, industrial sensors, and connected appliances benefit from the small size and low power consumption of SoCs.
- **Consumer Electronics:** Televisions, gaming consoles, and digital cameras use SoCs for multimedia processing and connectivity.
- **Healthcare:** Medical devices leverage SoCs for portable diagnostics, monitoring, and imaging.



Challenges in SoC Architecture

Design Complexity

- Integrating diverse functional blocks onto a single chip increases design complexity, requiring advanced tools and methodologies.

Verification and Testing

- Ensuring the correct operation of all integrated components is a major challenge, necessitating comprehensive verification and validation processes.

Thermal Management

- High integration densities can lead to heat buildup, requiring innovative cooling solutions and efficient thermal design.

Limited Modularity

- Unlike systems built from discrete components, SoCs offer limited options for upgrading or replacing individual parts, impacting flexibility and repairability.



Thank you

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