Projects Session
- Introduction -

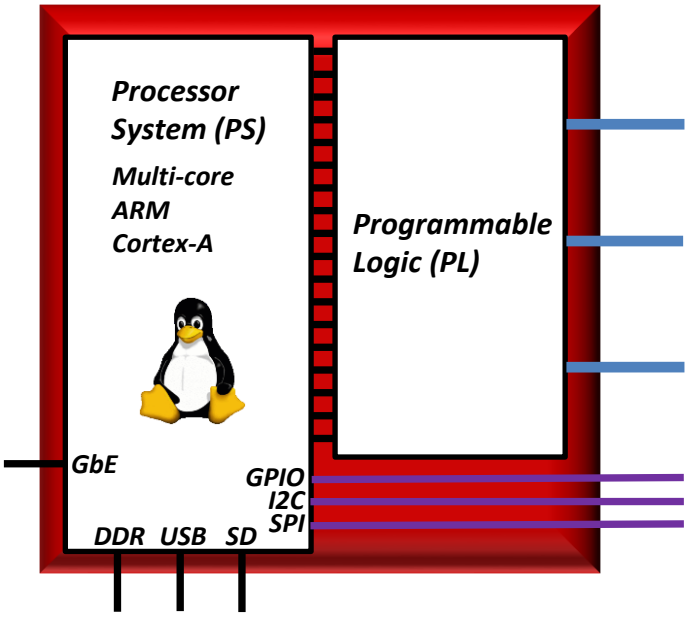
What is a SoC?

Our definition of SoC is more restrictive than, e.g. in Wikipedia

System-on-Chip (SoC) =

Programmable Logic + Processor System ⇒ ***"FPGA and CPU"***

- **Programmable logic (PL) =** ***like FPGA***:
  - Has logic cells, memory blocks, and I/O links, e.g. Multi-Gigabit Transceivers (MGTs)
  - Implements real-time data logic, interfaces to other FPGAs, can implement specific links, e.g. 10GbE, etc.
- **Processor system (PS) =** ***like CPU***:
  - Currently all are multi-core ARM processors
  - Has memory and peripherals, e.g. GbEthernet, I2C, SPI, GPIO, etc.
  - Runs software: either "bare-metal" application or operating system, e.g. Linux



⇒ Combines hardware and software!

Who uses SoCs?

System-on-Chip Interest Group: system-on-chip@cern.ch:

- **Launched in 2018**
- **Open to every CERN project or CERN-related project**
- **Today >170 members**

How many projects?

Launched a survey in May 2022

- **Summary report: CERN-OPEN-2023-001, http://cds.cern.ch/record/2847967**
- **Presentation of results: https://indico.cern.ch/event/1277467/**

⇒ 26 projects:

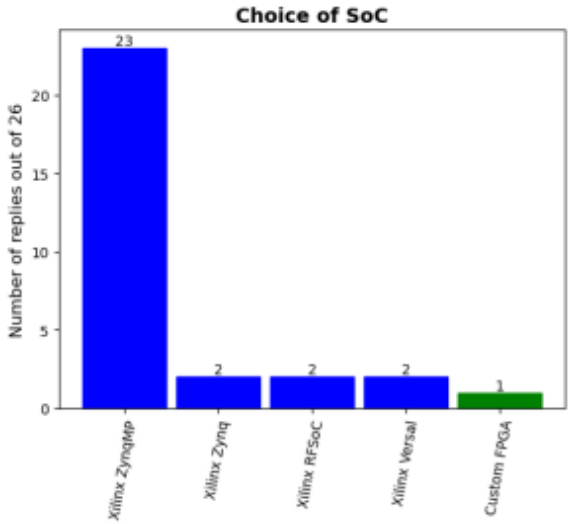
- **LHC Experiments: ATLAS & CMS, some other experiments: e.g AMBER, and also experimental tests sites, e.g. CARIBOU**
- **HSE Radio Protection: CROME**
- **Accelerator & Technology Sector: White Rabbit, DI/OT, FGC4, etc.**

How many SoCs?

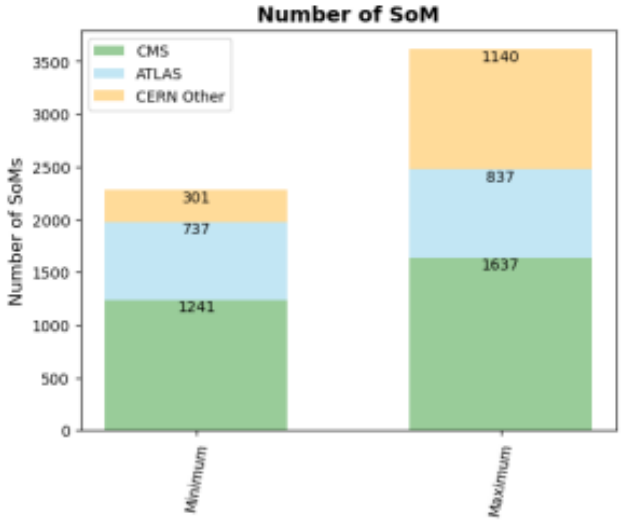
Question has two aspects

1) How many different types?

Xilinx Zynq 7000, Ultrascale+ MPSoC, RFSoC, Versal, and home-made (rad-tol)



From SoM survey,
estimations from of 2022



2) How many instances?

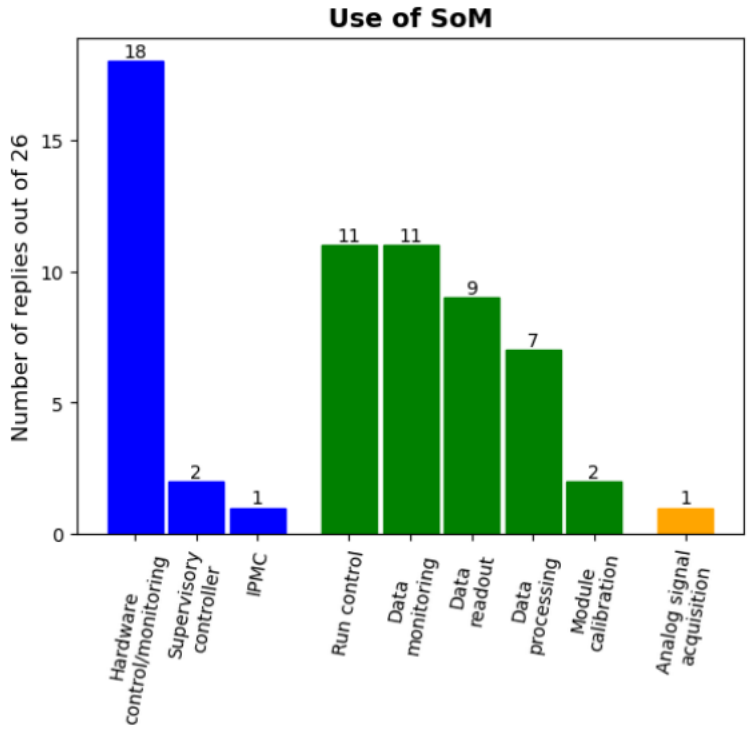
Projection for LHC Phase-2 upgrade (for Run 4, 2029-2033): between 2300 and 3600

1 SoM = 1 SoC

What are SoCs being used for?

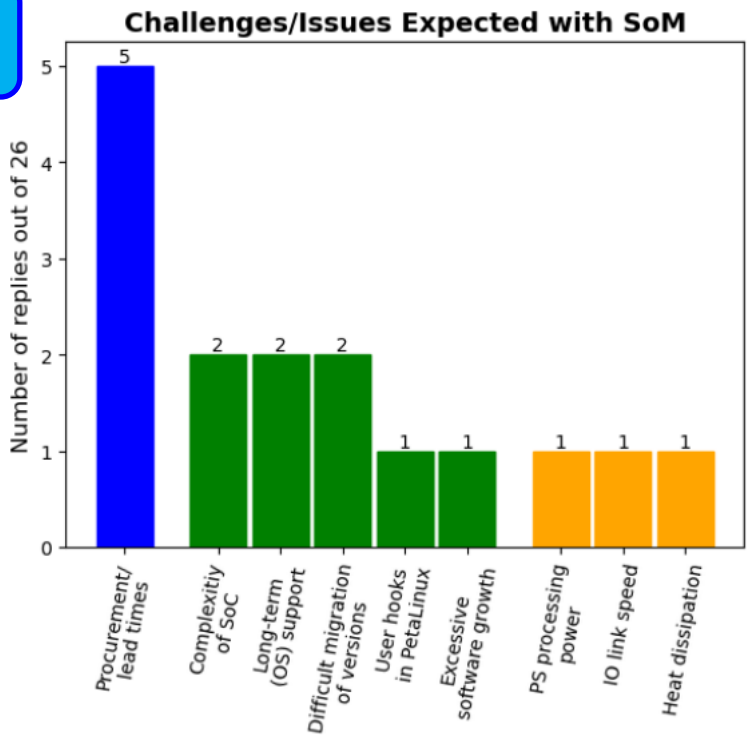
- **Hardware Control:**
  - **Typically, I2C, SPI, JTAG, FPGA configuration, etc.**
- **Run Control:**
  - **Operational control of PL firmware or of other processing FPGAs (Chip2Chip): start/stop and parameters**
- **Data Flow:**
  - **Acquisition usually from fast links in PL**
  - **Readout to PS fully or partial (monitoring)**
  - **Processing of data in PL and/or PS**
  - **Use of data for calibration of detector**
- **Analogue signal acquisition:**
  - **HL-LHC IR1/IR5 Beam Position Monitors**

From SoM survey of 2022



What challenges present SoCs?

From SoM survey of 2022



- **In 2022 lead times were considered the most important challenge**
- **But there are also challenges on the particular structure of the SoCs in terms of hardware and software**
  → co-development?

Other challenges are:

- **Long-term support**
- **Support for automating build software:**
  → continuous integration?

In addition, not directly seen on the plot:

- **Question of common operating system**
- **Support for system integration/administration**

Projects' sessions

- **19 presentations scheduled over the next three afternoons**
- **Large and interesting mix of hardware and software, of different uses, and on different tools**
- **Showing the state of the art**

Have a good journey across the multitude of SoC projects!