Embedded Linux Porting

Organised & Supported by **RuggedBOARD**

Presenter Profile

B Vasu Dev

Managing Director

PHYTEC Embedded Pvt Ltd

vasu.b@phytec.in

+91-9535504414

view my profile on LinkedIn

ABOUT Vasu

Vasu has 20+ Years of industry experience in Embedded Technologies mainly on ARM & Linux, he has worked at major MNC's like LG, Wipro, MIC Electronics and is currently heading PHYTEC INDA, a subsidiary of PHYTEC Messtechnik GmbH GERMANY as Managing Director. PHYTEC serves as OEM for many electronic and embedded companies to develop and deploy their products at the lowest possible time with high reliability and quality using ARM based SOMs (System On Modules) & SBCs (Single Board Computers). The industry verticals he was engaged are Industrial Automation, Mobility & Energy, Medical/Healthcare, Retail market.

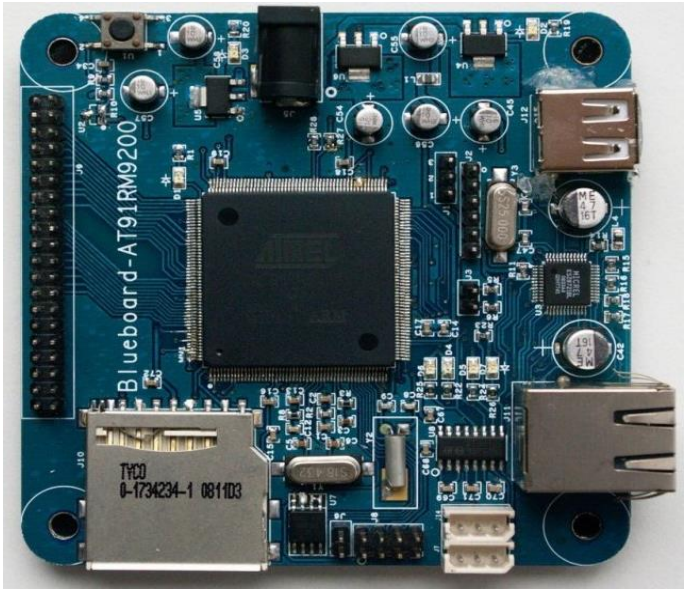
Apart from his technical work, he is an active coach & guide for Embedded developers and actively spend his time to train the developers on Embedded Linux, Yocto, IoT, Android System Development. He is the master mind behind RuggedBOARD Open Source Hardware Platform. Vasu as a mentor helped many start-ups to build their products and position them in market.

The Journey

LinkSys Router

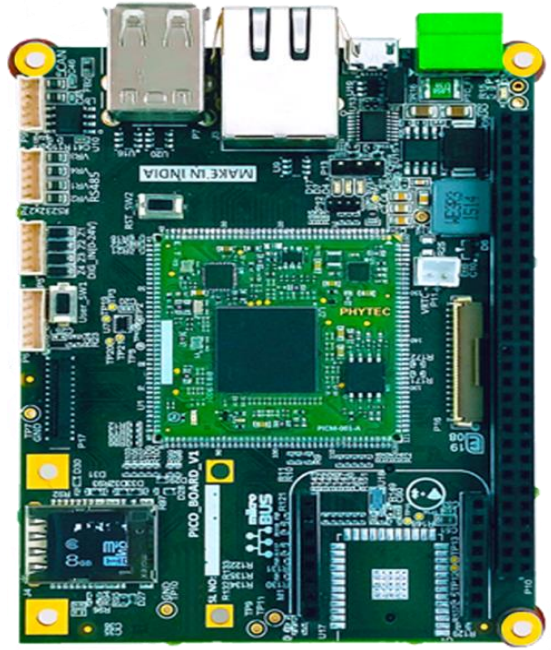
2005

BB-AT91



2009

RB-A5D2x



2019

Agenda

- Introduction to Embedded Systems
- ARM Processors Basics & Familes
- ARM Board Details & Schematic Overview
- Boot Process
- Host PC Setup for eLinux Development

Embedded Systems Classification

Rugged Board

S1.0

MCU Based
Very Low Power
Small Code (KB's)
Baremetal
Small RTOS

S2.0

MPU Based
High Speed (200MHz till 1GHz)
OS + Application Code

S3.0

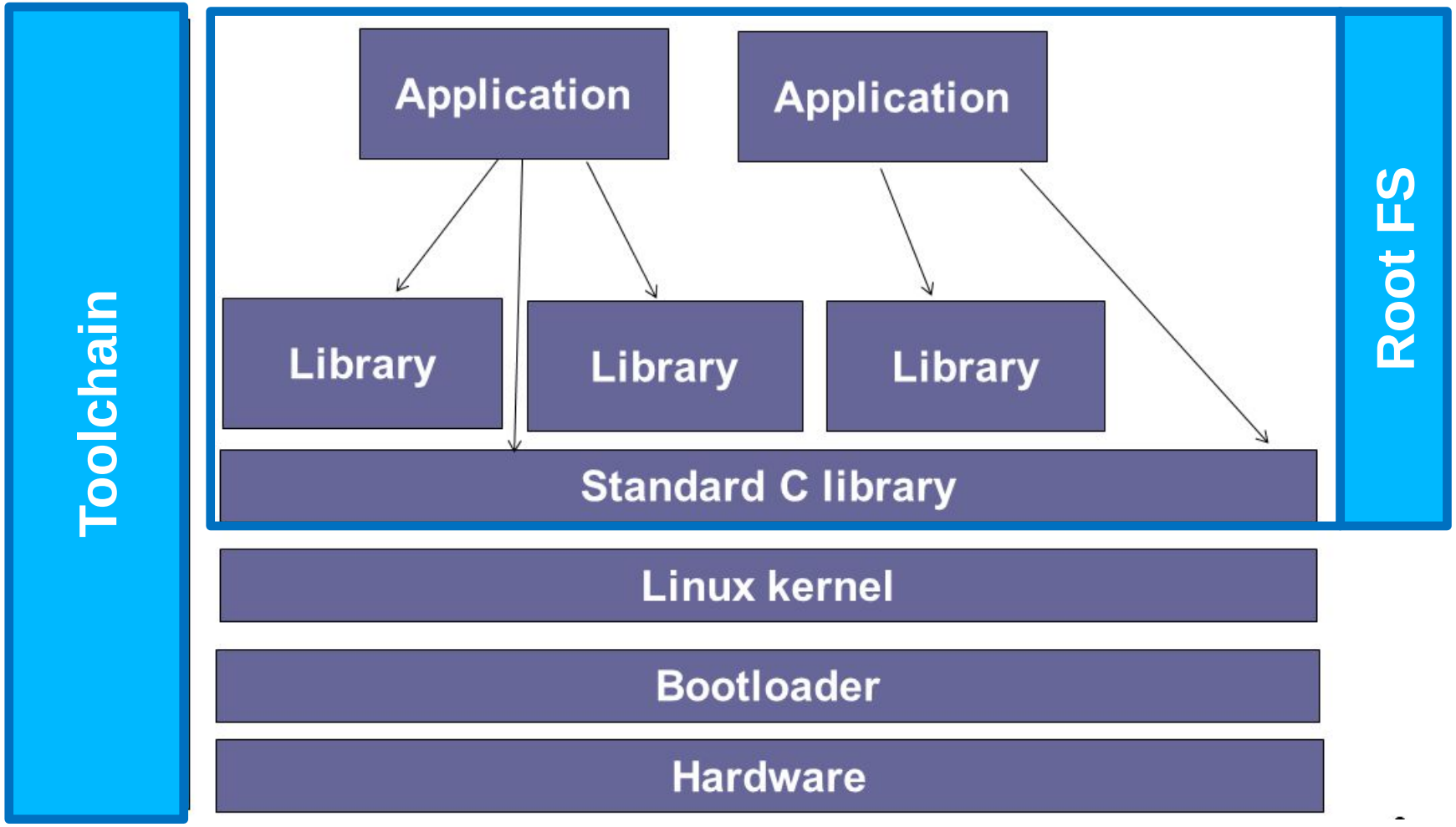
MPU+ Based
Special Co-Processors
Very High Computation Power
Special Hardware Accelerator Engines like TPU, VPU, GPU's

Mostly uses Cortex-M4 having BLE comm and few sensors need companion mobile

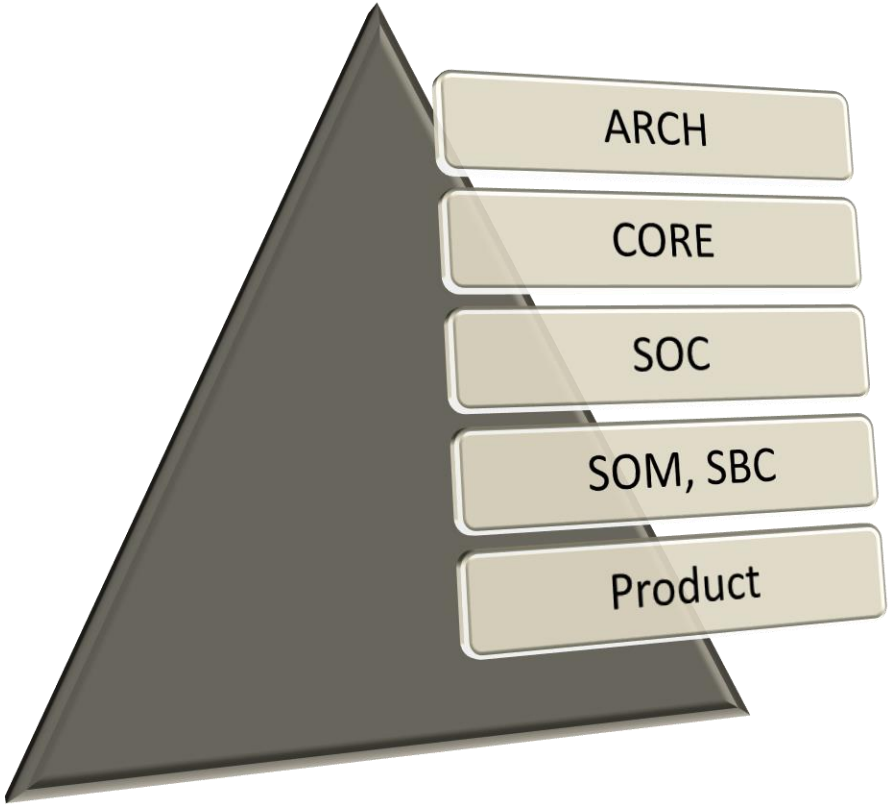
Mostly uses Cortex-A7, 4G comm friendly UI, make calls, check emails etc …

Mostly uses Cortex-53, 4G and advance AI/ML capabilities to process the data on-device and generate analytics & feedback

eLinux System ARCH



System Hardware



Processor Blueprint, defines IS & other hardware blocks of Processor

Processor design in VHDL / Verilog having ALU, Registors, TCU, Buses …

Silicon with Processor & peripherals like GPIO, UART, I2C, SPI, USB, Ethernet …

SOM = SOC+ RAM + Flash + PMIC, **SBC** = Board with SOM & interfacing devices like LCD, Connectors, Sensors & Communication modules

Product = SBC + Software + Housing/Mechanicals

Gateway → RuggedBOARD → phyCORE-A5D2x → ATMEL SAMA5D7 → ARM CORTEX-A5 → armV7a

ARM Cores

Embedded Cores

- Cortex-M55
- Cortex-M7
- Cortex-M33
- Cortex-M4
- Cortex-M3
- Cortex-M23
- Cortex-M0/M0+
- ARM-7

Application Cores

- Cortex-A72
- Cortex-A53/A55
- Cortex-A35
- Cortex-A17
- Cortex-A15
- Cortex-A9
- Cortex-A8
- Cortex-A7
- Cortex-A5
- ARM-9
- ARM-11

Real-Time Cores

- Cortex-R82
- Cortex-R52
- Cortex-M8
- Cortex-R7
- Cortex-R5
- Cortex-R4

ARM SOC's & Vendors

SOC Vendors	Platforms
TI	AM335x, AM437x, AM572x
NXP	imx6ULL, imx6(S/D/Q), imx8
Microchip	SAML1x, SAMA5D2x
ST Microelectronics	STM32MP15x
Renesas	RZ/A1x, RZ/G1x, RZ/G2x
Rockchip	RK3036, RK3288, RK3399
Qualcomm	Snapdragon 200, 400, 800
Mediatek	MT8312, MT8135, MT8176
Amlogic	S805, S812, S912
Allwinner	A2x, A3x, A6x

eLinux SBC

	**Raspberry Pi 3 Model B**	$35.71	Broadcom BCM2837 (4x up to 1...	1 GB
	**Qualcomm DragonBoard**	$75	Quad-core ARM® Cortex® A53 a...	1GB LPDDR3 533MHz
	**Raspberry Pi Zero W**	$10	-	-
	**Raspberry Pi Zero**	$5	Broadcom BCM2835 1Ghz, Sing...	512MB LPDDR2 SDRAM
	**ODROID-XU4**	$74	Samsung Exynos 5 Octa 5422 (...	2Gbyte LPDDR3 RAM PoP stac...
	**The Parallella Board**	$99	ARM Cortex-A9 dual-core, Epip...	1GB DDR3 SDRAM
	**Intel NUC**	$120 +	Intel Celeron, Pentium, Core	SO-DIMM
	**PINE A64**	$15	1.2 GHz Quad-Core ARM Cortex...	512MB / 1GB / 2GB

eLinux SBC

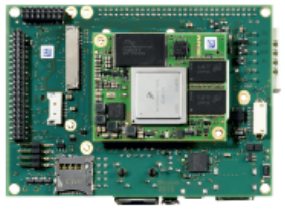
	ASUS Tinker Board	$59.99	Rockchip RK3288-C (4x up to 1....	2 GB LPDDR3
	Rock64	-	Rockchip RK3328	1/2/4GB
	up board	$89+	Intel Atom x5-Z8350 (4x 1,44 G...	1, 2 or 4 GB
	Intel NUC boards	$115-$575	-	-
	LattePanda 4G/64GB	$159	Intel Atom x5-Z8350 Prozessor	4 GB
	ODROID-C2	$40	Amlogic ARM Cortex-A53(ARM...	2GB DDR3 SDRAM
	Orange Pi PC	$15	A7 Quad (Allwinner H3) 1.3GHz	1GB DDR3 SDRAM
	BeagleBone Black	$55	AM335x 1GHz ARM® Cortex-A8	-

eLinux SBC

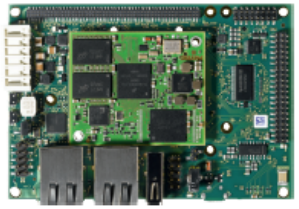
NEW

	phyBOARD-Polaris	phyBOARD-Wega	phyBOARD-Regor
Module	phyCORE-i.MX 8M	phyCORE-AM335x	phyCORE-AM335x
SOM Mounting	BGA	Soldered (DSC), Connector insertion	Connector insertion
CPU	i.MX 8M Quad	AM335x	AM335x
Clock Frequency	4x 1.3 GHz	600 MHz up to 1 GHz	1 GHz
Memory	1 GB RAM, 8 GB eMMC, 4 kB EEPROM	128 MB NAND Flash, 256 MB DDR3 RAM, 4 kB EEPROM	512 MB NAND Flash, 512 MB RAM, 8 MB SPI Flash, 4 kB EEPROM
INTERFACES			
Ethernet	1x 10/100/1000 Mbit/s	2x 10/100 Mbit/s	2x 10/100 Mbit/s
USB	1x USB3.0 Host, 1x USB OTG	1x Host, 1x OTG	1x OTG
Serial	1x RS232	2x RS232	2x RS232, 1x RS485
CAN	–	1x	1x CAN non-isolated
Digital I/O	optional via Expansion Connector	–	4x
Audio	SAI via A/V Connector	1x Stereo Line In, 1x Stereo, Speaker Line-Out	–
PCIe	1x miniPCIe	–	–
Camera	2x MIPI-CSI	–	–
Mass Memory	microSD Card Slot	microSD Card Slot	microSD Card Slot
EXPANSION & CONFIGURATION			

eLinux SBC



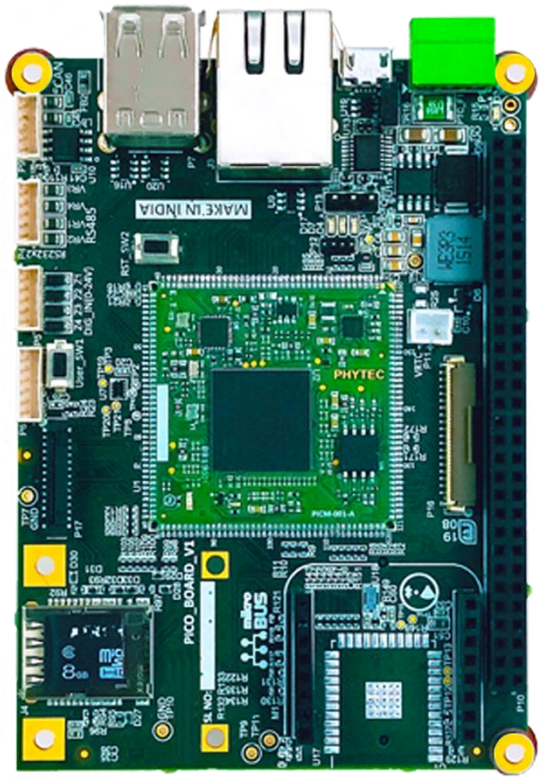
NEW



phyBOARD-**Mira**	phyBOARD-**Nunki**	phyBOARD-**Segin**	phyBOARD-**Zeta**
phyCORE-i.MX 6	**phyCORE-i.MX 6**	**phyCORE-i.MX 6UL/ULL**	**phyCORE-i.MX 7**
Connector insertion, Soldered (DSC)	Connector insertion	Half-Hole Technology	Connector insertion, Soldered (DSC)
i.MX 6Solo, i.MX 6Quad	i.MX 6Quad	i.MX 6ULLY0, i.MX 6ULG2	i.MX 7Solo, i.MX 7Dual
up to 4x 1 GHz	4x 1 GHz	up to 792 MHz	1 GHz + 200 MHz
up to 1 GB NAND Flash, up to 1 GB RAM 64 Bit, up to 16 MB NOR, 4 kB EEPROM	1 GB NAND Flash, 1 GB RAM, 16 MB NOR, 4 kB EEPROM	up to 512 MB SLC NAND, 512 MB DDR3L RAM, 4kB EEPROM	up to 8 GB NAND or up to 128 GB eMMC, up to 2 GB DDR3, 16 MB QSPI NOR, 4 kB EEPROM
up to 1x 10/100/1000 Mbit/s	1x 10/100/1000 Mbit/s	up to 1x 10/100 Mbit/s	2x 10/100/1000 Mbit/s
1x Host, 1x USB Host/OTG	1x Host, 1x OTG	up to 1x Host, 1x OTG	1x Host, 1x OTG
1x RS232	via microUSB	1 x RS232 or 1x RS485	2x5 pin header
up to 1x CAN non-isolated	1x	up to 1x CAN	2x5 pin header
via Expansion Bus	via Expansion Bus	via Expansion Bus	4x UART, 3x I2C, 2x SAI, 2x MMC/SD/SDIO, 3x SPI
via optional AV-Adapter	via Expansion Bus	1x Stereo Line In, 1x Stereo Line Out, 1x Speaker Out	via AV-Connector
up to 1x miniPCIe	1x miniPCIe	-	1x miniPCIe
up to 1x parallel, CSI	2x, both with phyCAM-P or phyCAM-S+ or one with MIPI CSI-2	up to 1x parallel, CSI	MIPI CSI
microSD Card Slot	microSD Card Slot, SATA	microSD Card Slot	microSD Card Slot

Board used for this Training

RuggedBOARD



- A5D2x @500MHz
- Cortex - A5
- 64MB Ram
- 32MB Flash
- 2 x RS232
- 1x RS485
- 1 x CAN
- 1 x Ethernet
- TFT & Cap Touch
- 1 x MicroSD Slot
- 2 x USB
- DC & USB Power
- Expansion Header
- mikroBUS Conn.
- mPCIe conn.
- Micro Sim Slot

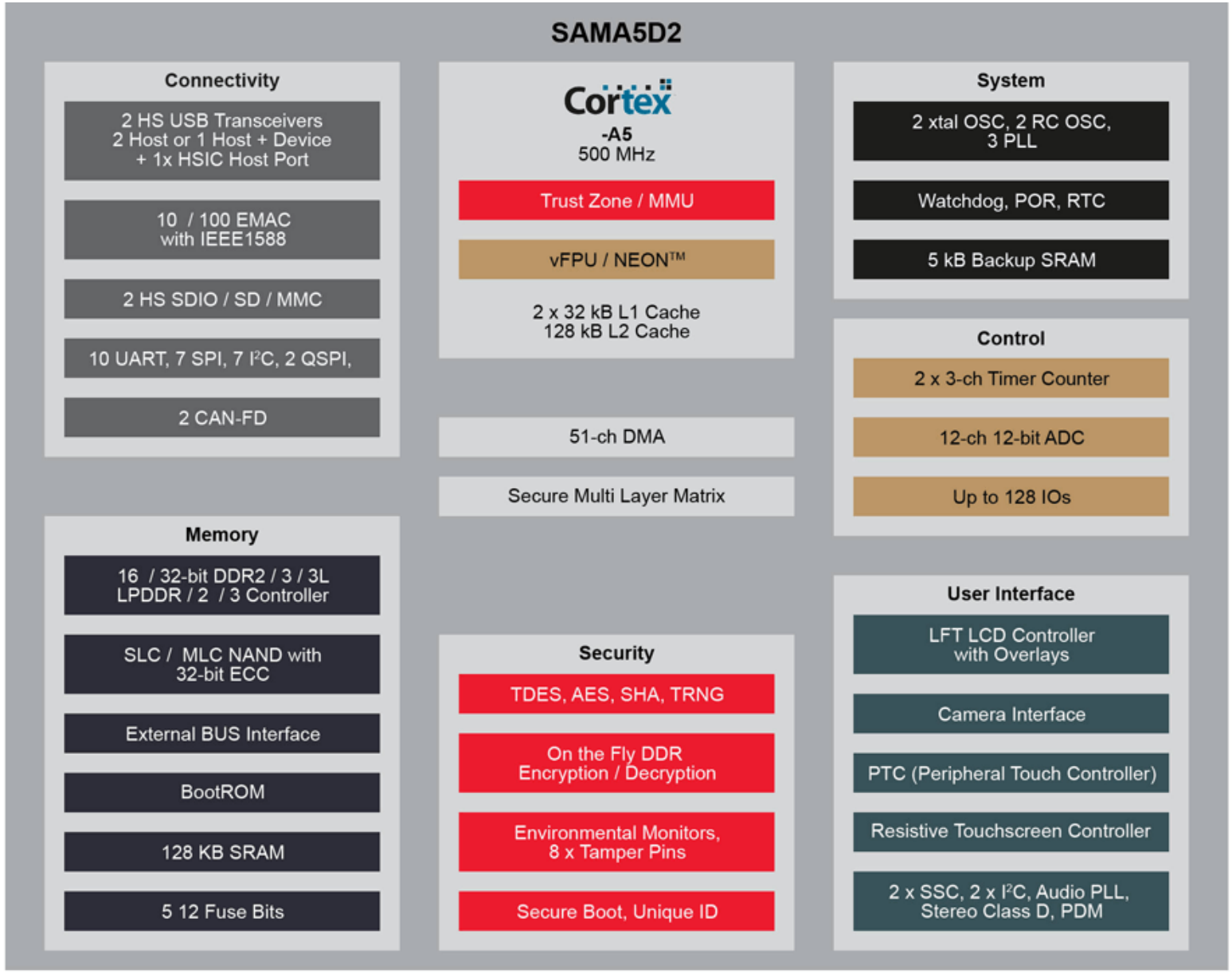
open source hardware

open source initiative

Industrial Grade Hardware for IIoT

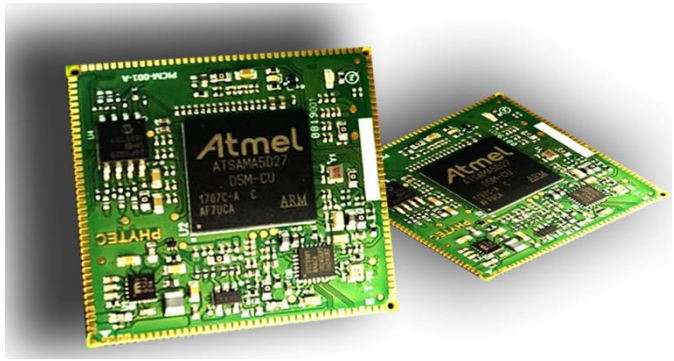
https://Community.ruggedboard.com

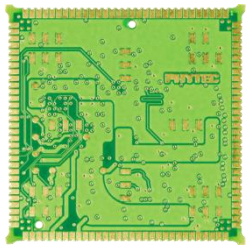
ATMEL SAM-A5D2x SOC



phyCORE-A5D2x SOM

Speed & intelligence out of the box





Solder-Down Module

Cortex®-A5

36 mm x 36 mm

EASIER

Building a new embedded device from the ground up is an enormous challenge and risk. Embedded development can be made much easier by leveraging existing solutions.

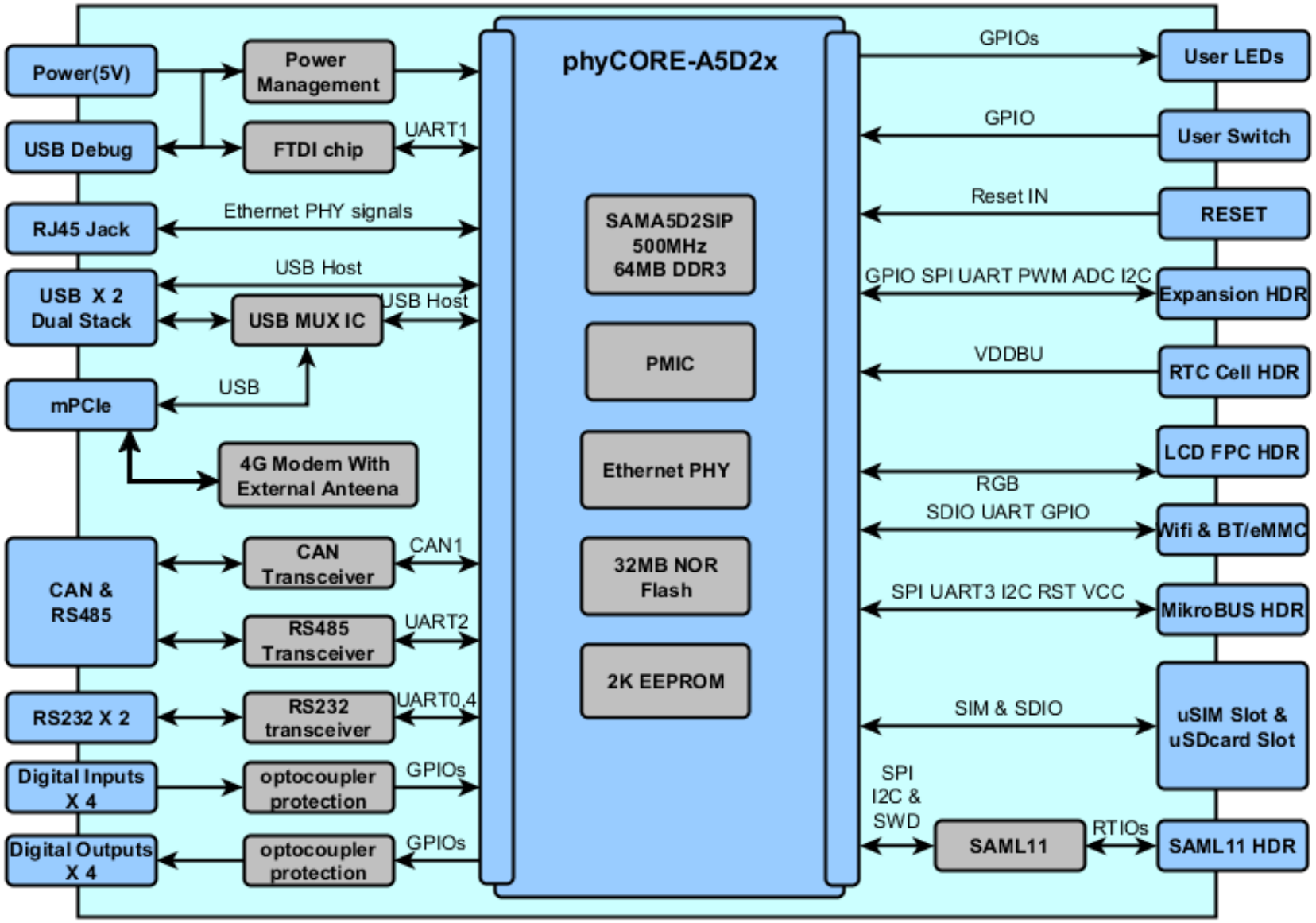
FASTER

Deploy a production-ready SOM and BSP and eliminate 6-12 months from your development timeline.

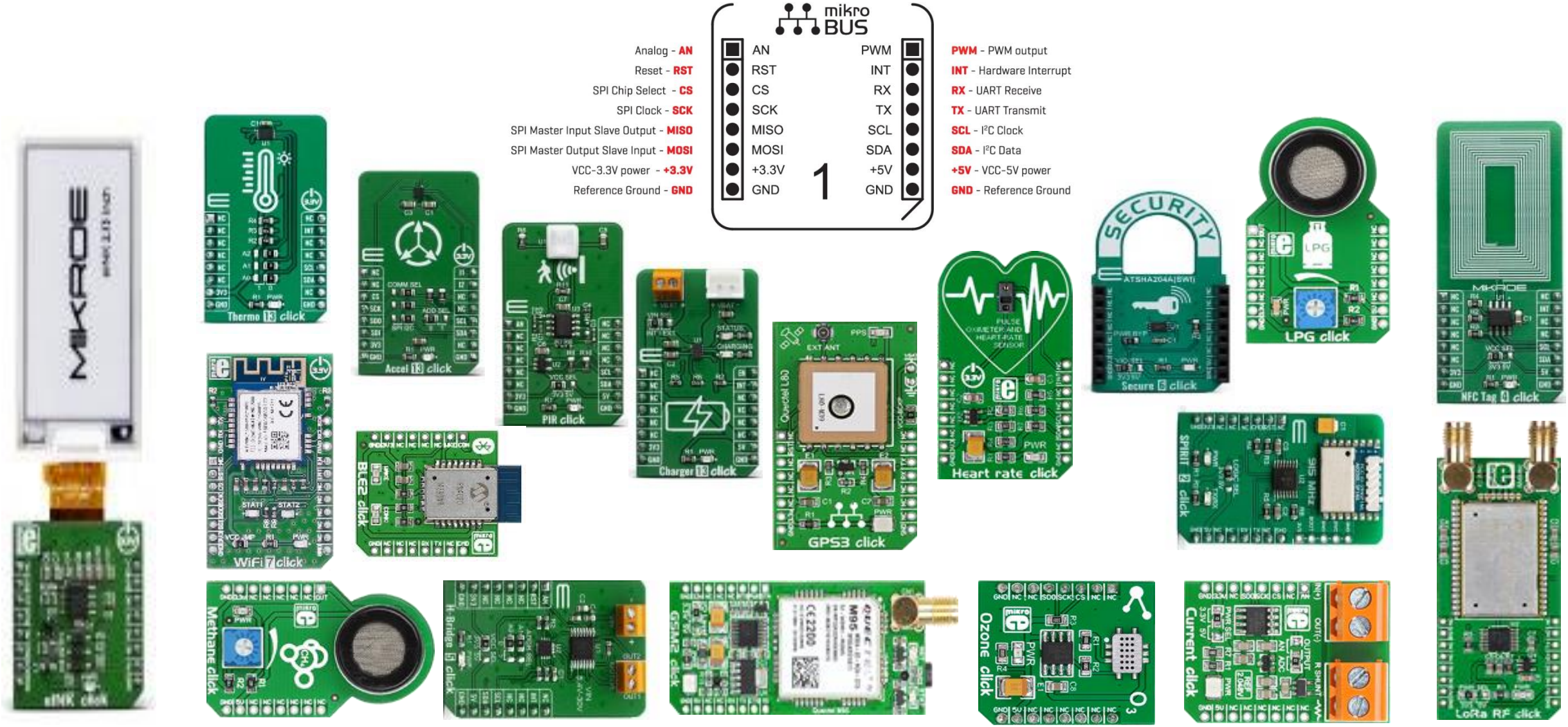
CHEAPER

Save substantial non-recurring engineering costs by eliminating specification, parts selection, schematic, layout, validation, and Operating System porting efforts. Use an off-shelf SOM and BSP instead.

RB-A5D2x SBC BlockDiagram

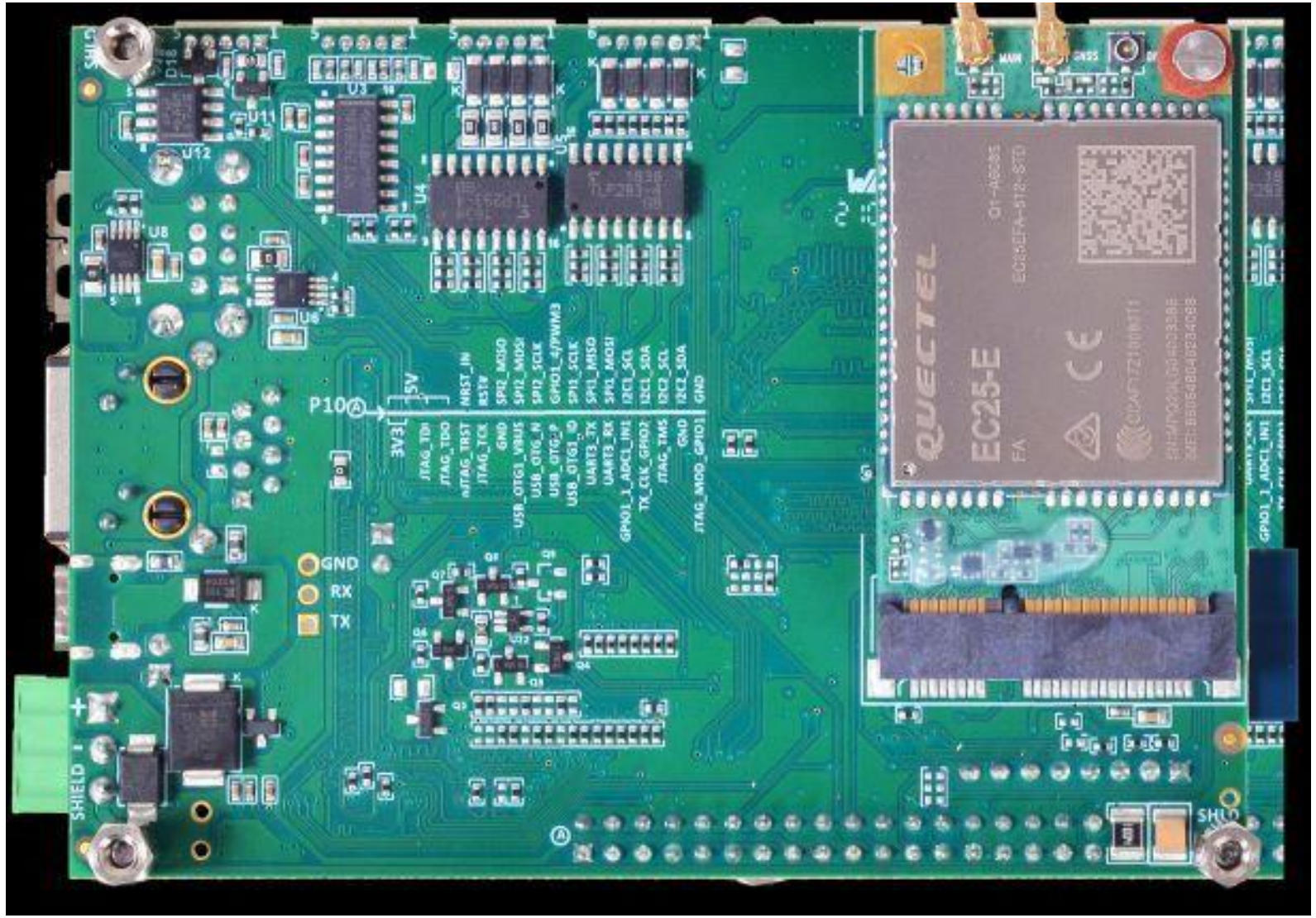


MicroBUS Add-On Boards



Add-On Modules for Quick Prototyping

mPCIe Modules



mPCIe 3G/4G Modules

mPCIe LoRA Modules

Boot Process

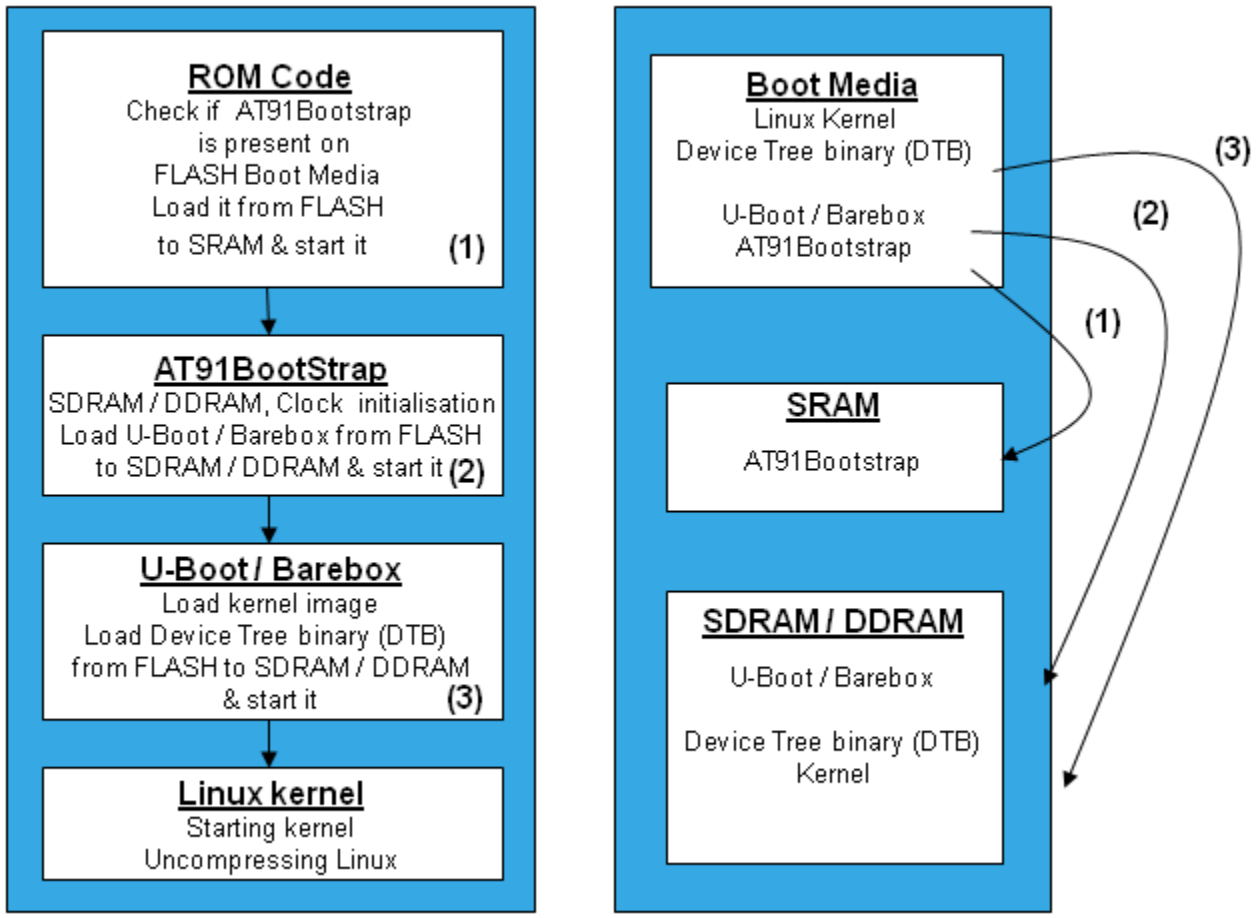
ON PC:

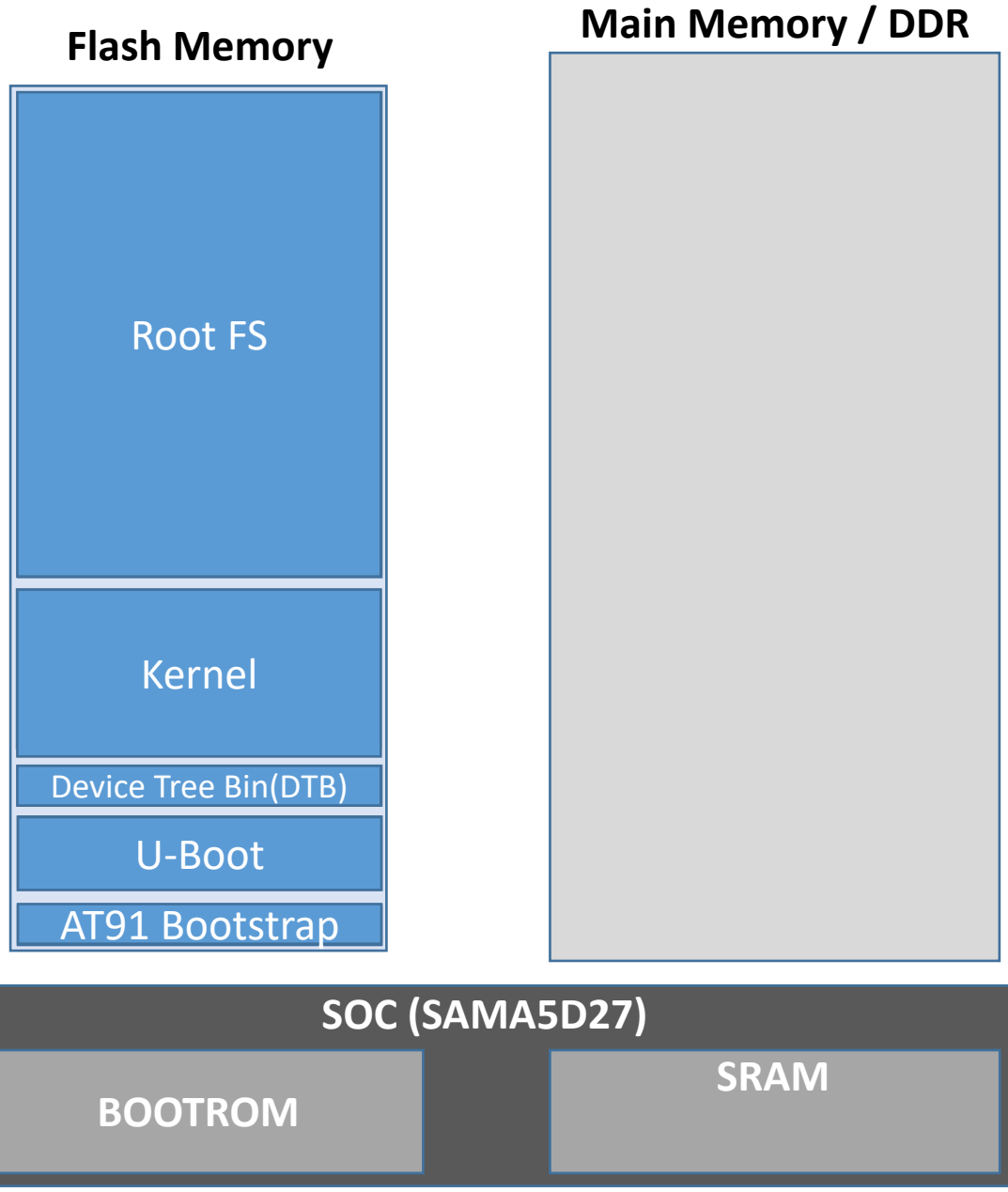
Power On-> BIOS (POST, Bootstraploader) -> MBR -> Bootloader -> Kernel -> RFS

ON RuggedBOARD:

1. Power On SBC
2. SOC BootROM Code will exec
3. BootCFG Pins will define the bootdevice (NAND, NOR, SDCARD .....)
4. From Bootdevice first piece of code (PBL) loaded in SRAM and executed
5. PBL responsible for External RAM Init and loads the BL to External RAM and execute.
6. BL will load the kernel and executes
7. Kernel boots and mounts the RootFS and finally executes the init binary
8. Init will follow init rc scripts to start services and applications

Boot Process





Connect-us

Open Discussions