



**Nuclei RISC-V Processor**

# **300 Series Product Brief**

## Overall Introduction

**Nuclei N300 Series** is a 32b embedded processor based on RISC-V architecture that is compatible with RV32IMACFDBPKC/Zcxlcz. N300 Series features a **3-stage, in order pipeline**, of which the **N30x Series is single-issue core while N310 Series is dual-issue core**, giving better performance with relatively small area increasement.

N300 Series delivers great performance. **Single-issue N30x** gives 1.87/4.7(legal/best) Dhrystone/MHz, 3.71 Coremark/MHz; **Dual-issue N310** gives 2.07/5.13(legal/best) Dhrystone/MHz, 4.21 Coremark/MHz.

N300 Series supports both instruction and data local memory (**ILM/DLM**) gives better real time processing capability. User can also configure instruction and data cache (**I-Cache/D-Cache**) to improve the performance of the overall subsystem.

N300 Series supports various RISC-V extensions, including **single/double precision floating point, DSP, NICE(Nuclei Instruction Co-unit Extension), and TEE(Trusted Execution Environment)**, etc., giving customer rich configuration features.

N300 Series works well for low power applications, and is under mass production in MCU, AIoT, Connectivity and Industrial application.



Extreme Cost Effective



RV32 IMACFDBPKC/Zcxlcz



3-stage Pipeline Single/Dual Issue Configurable



Support I/D-Cache



PMP and TEE Security Features



Single/Double Precision FP and SIMD DSP Unit



NICE Custom Instruction Extension



AHB-Lite System Bus



RISC-V Standard Debug



4-Wire JTAG 2-Wire cJTAG



Low Latency Interrupt



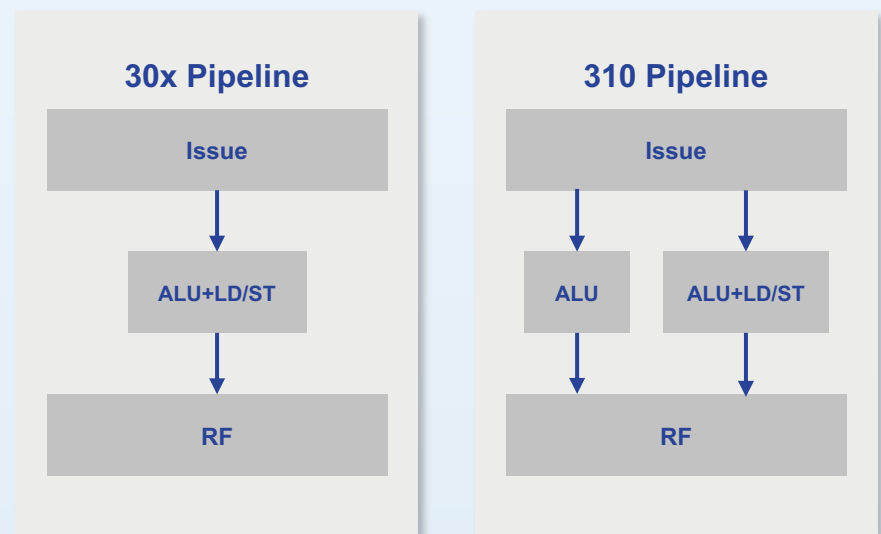
Full Dev Kit & SDK

## N300 Features

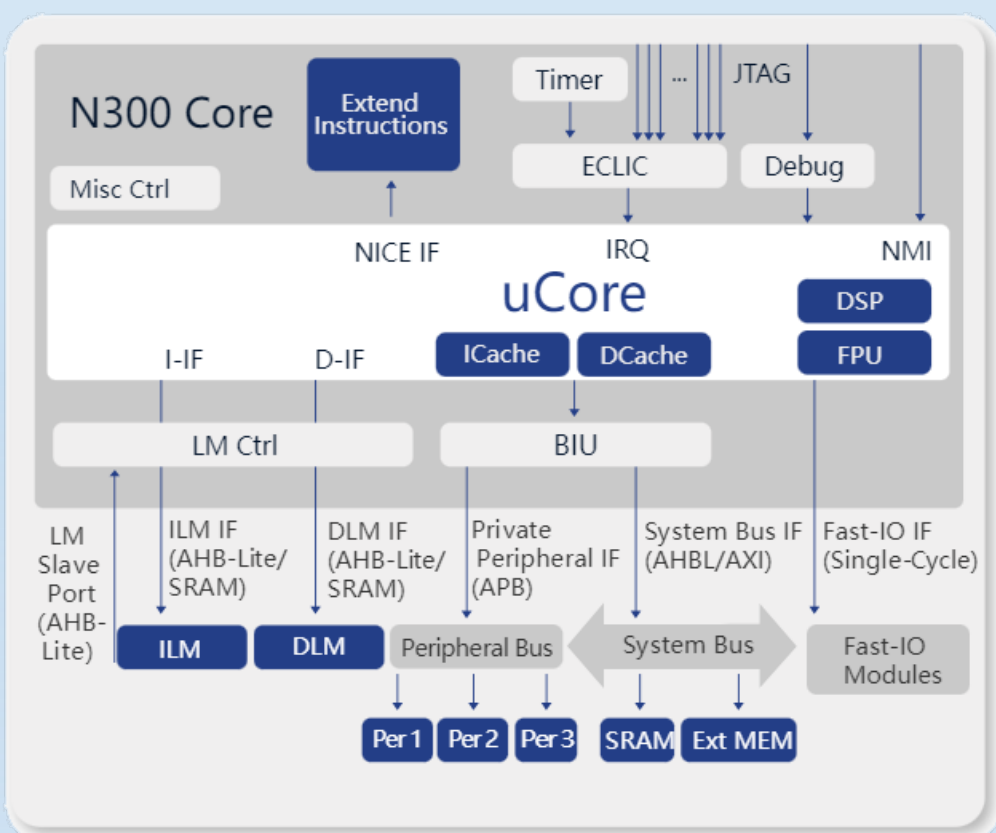
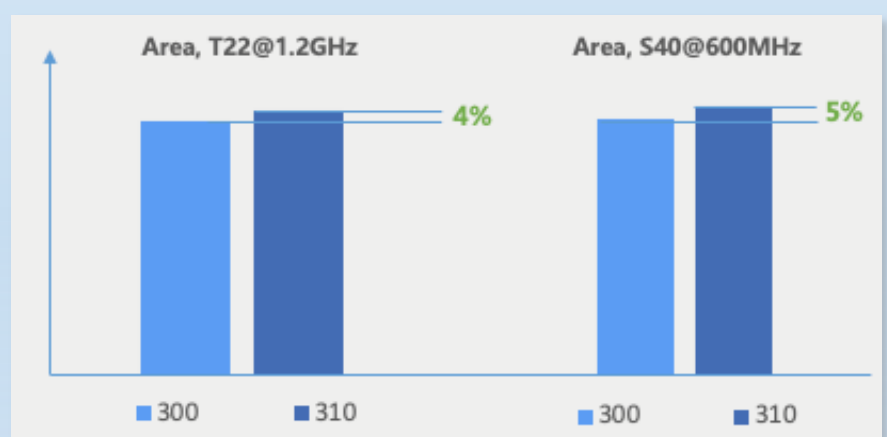
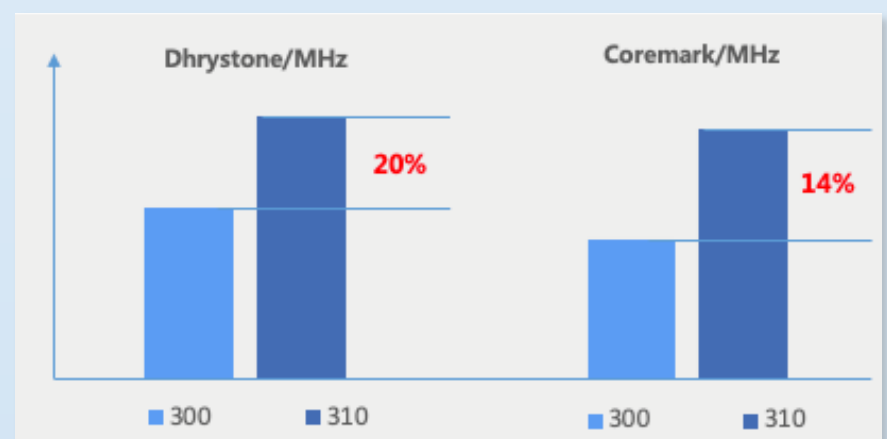
- RV32IMACFDBPKC/Zcxlcz compatible, can be configured to N305, N307, N308 and N310;
- Support **fast interrupts tail-chaining mechanism**, **vectored interrupt processing** and **software dynamically programmable division of interrupt levels and priorities**; Provide advanced low latency interrupt feature for **real-time application**;
- Can be configured to **dual-issue**;
- Support Custom Instruction Extension(**NICE**);
- Configurable **ILM (Instruction Local Memory)** & **DLM(Data Local Memory)** with **ECC**;
- Configurable **I-Cache** with Scratchpad mode & **D-Cache** with **ECC**;
- **Double/Single Precision** floating point and **DSP** Extension;
- Supervisor mode is supported for **TEE (Trust Execution Environment)**;
- Support standard **JTAG & cJTAG** interface and Linux/Windows debug tools;
- Support standard RISC-V GNU toolchain and Linux/Windows dev environment (**IDE**)

## N300 Series Dual-issue Delivers Better Performance

Dual-issue N310 adds an extra **ALU Unit**, providing higher computing power.

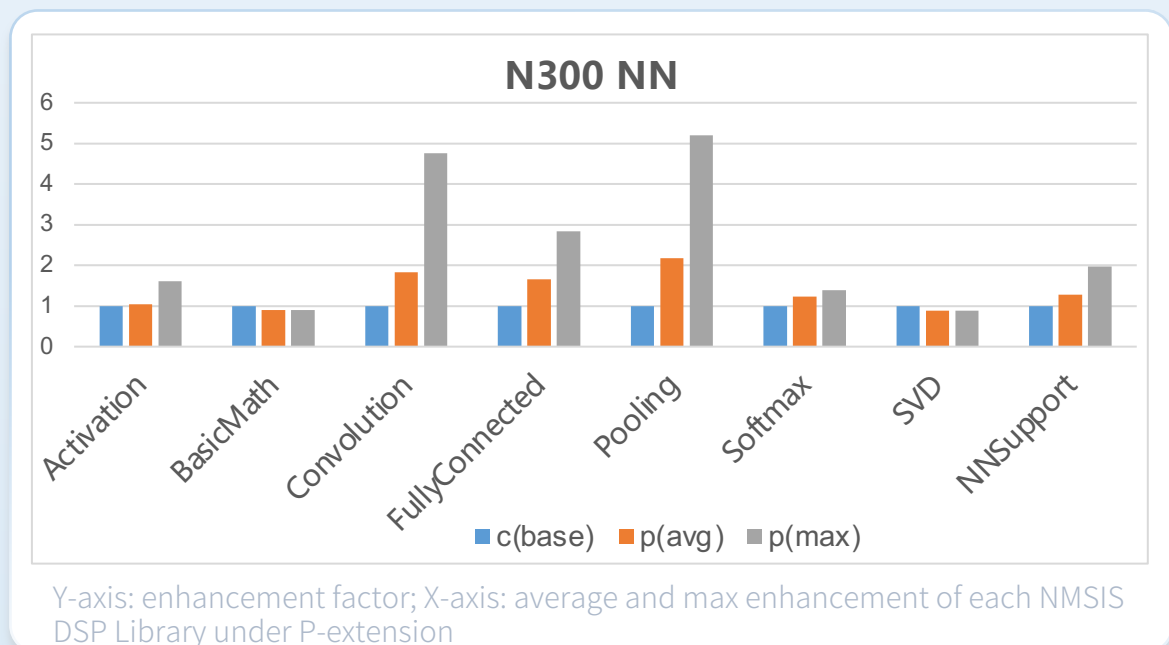
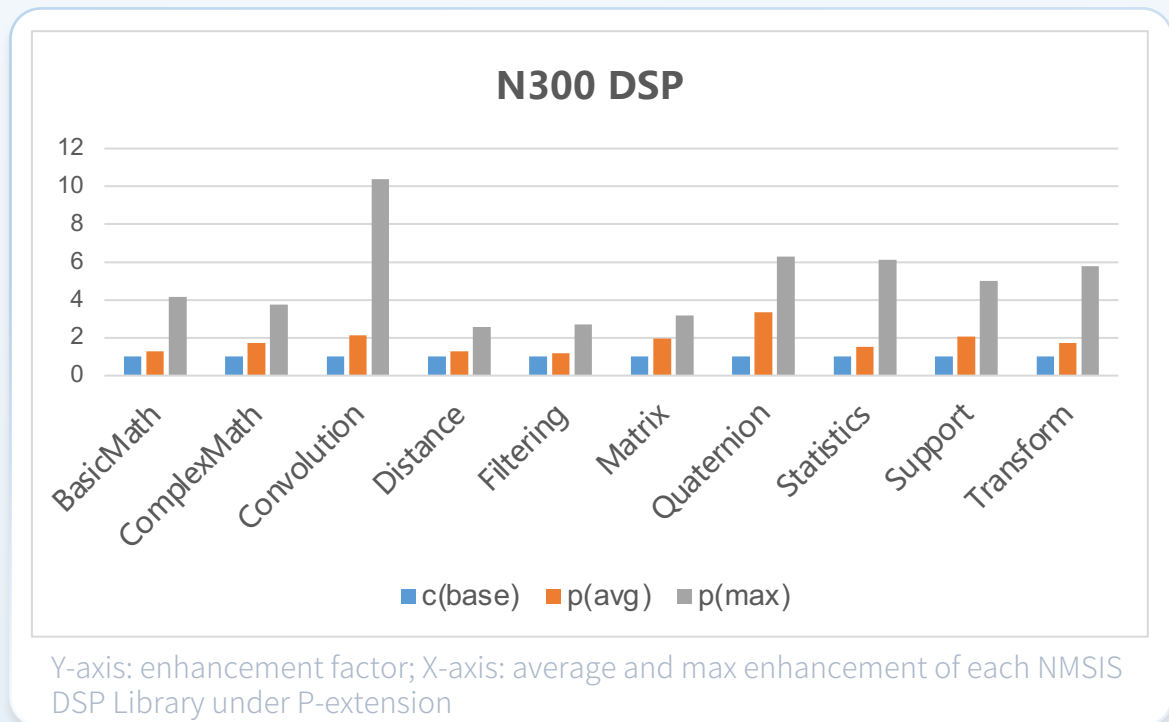


N310 provides **more than 15%** performance enhancement compared to N30x with relatively small area penalty.



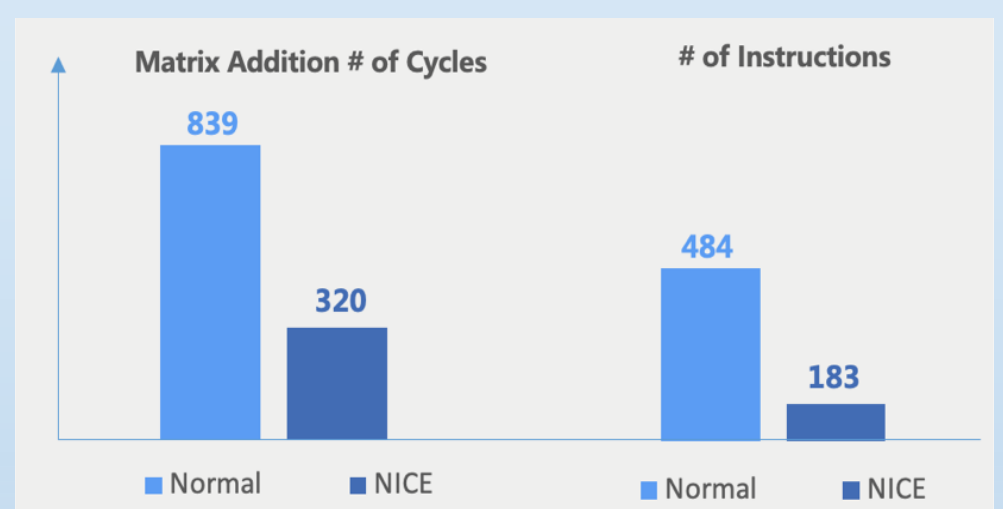
## N300 DSP Extension

- Support **Packed-SIMD DSP** features that follow RISC-V “P” Extension;
- Can be configured with Nuclei **custom DSP instruction**: change any particular Byte to XLEN GPR;
- Support 3 extra extensions: N1, N2 and N3, **increasing SIMD parallel computing performance by 1x** ;
- Support **DSP Library NMSIS**, which is compatible with ARM CMSIS, helping customer to process complicated DSP computation;
- Detailed definition and supported instruction can be referred here: [Nuclei® RISC-V Packed-SIMD DSP QuickStart](#)



## N300 NICE Custom Instruction Extension

- All Nuclei processor IPs support **NICE(Nuclei Instruction Co-unit Extension)**, allowing customization capability;
- Combine customized hardware co-processor with N300, providing DSA better performance with low power;
- Embed customized instructions only use **Intrinsic Function**;
- As shown in the figure, number of matrix processing cycles and instructions get reduced significantly using NICE custom instructions



## N300 Memory Subsystem

N300 Series supports local instruction and data memory: **ILM (Instruction Local Memory)** 和 **DLM (Data Local Memory)**, providing real-time processing capability:

- ILM and DLM can be configured from **128B-2GB**, allowing excellent flexibility;
- **AHB-Lite interface and SRAM interface** with customized **address space**.

N300 Series supports Instruction Cache

- **2-way, 32B cache line** structure
- Cache size from **1KB-64KB**
- If ILM is not configured, I-Cache can be configured to **Scratchpad Mode** through CSR
- Support cache line **LOCK and INVAL** operation

N300 Series supports Data Cache

- **2-way, 32B cache line** structure
- Cache size from **1KB-64KB**
- Support cache line **LOCK and INVAL** operation

## N300 System Interface Introduction

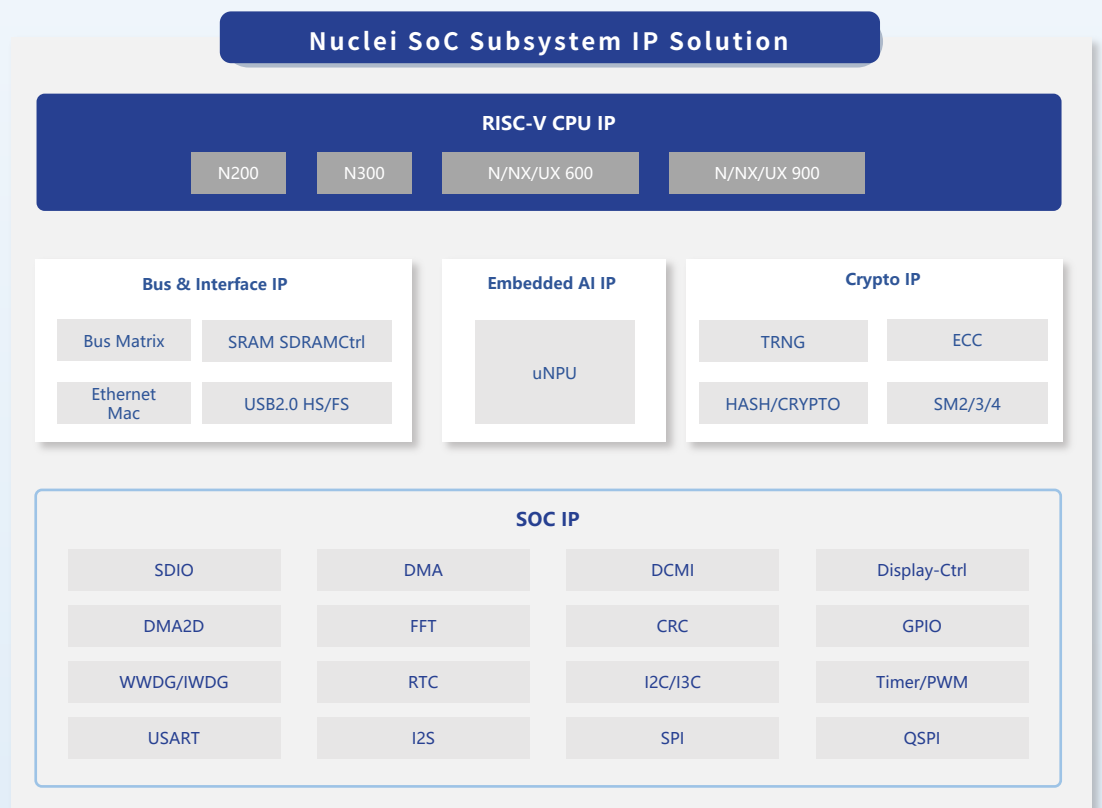
Bus Interface	Description	Atomic Support	Burst Support	Cacheability	Protocols	Bus Width
<b>System Bus</b>	System Instruction and Data	Yes	Yes	Configurable	AHB-Lite/AXI	32 bit
<b>I-Cache Bus</b>	Used for I-Cache miss	No	Yes	Configurable	AHB-Lite	32 bit
<b>ILM Interface</b>	Local Instruction	No	No	No	SRAM/ AHB-Lite	32 bit
<b>DLM Interface</b>	Local Data	No	No	No	SRAM/ AHB-Lite	32 bit
<b>PPI Interface</b>	Private Peripherals	No	No	No	AHB-Lite	32 bit
<b>Slave Interface</b>	External Master Read	No	No	No	AHB-Lite	32 bit



## Nuclei CPU Subsystem

Using internal tools from Nuclei to integrate CPU IPs with other peripheral IPs, verify and deliver a **full subsystem solution** to customer.

- Save money: Full subsystem IP **reduces customer's cost**;
- Save time: Fully customized SoC subsystem **saves customer's development cycle**;
- Save effort: Related SoC driver and SDK help **fast prototype bring up**.

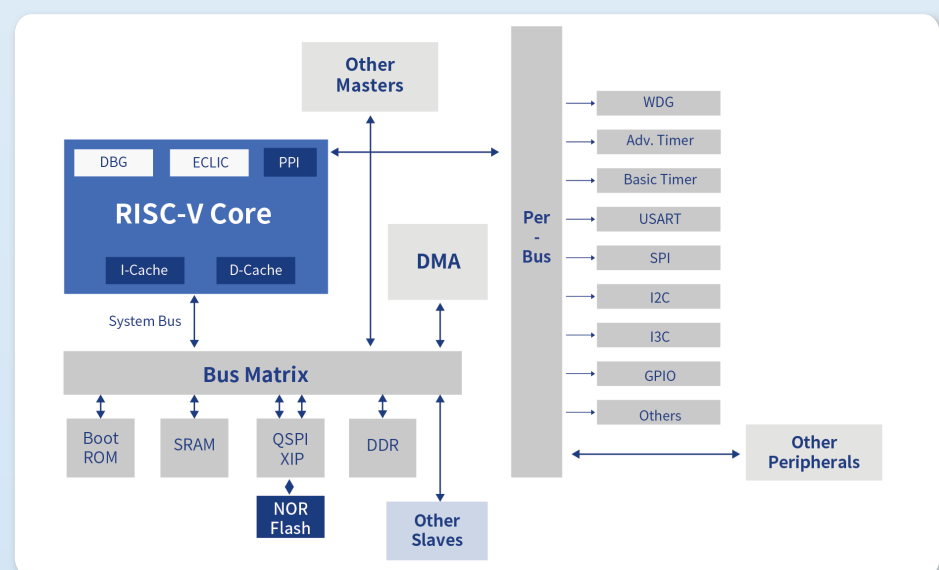


## Innovative Subsystem IP Use Case

### Use Case #1

Single-core:

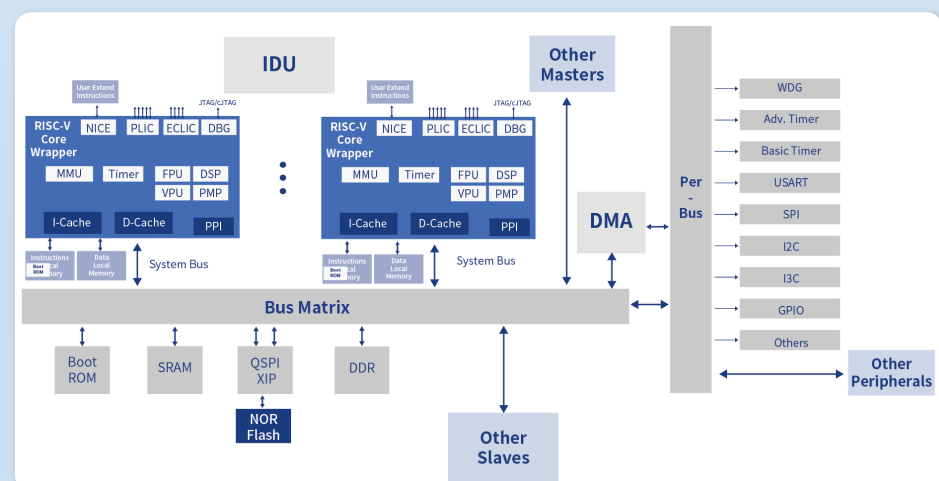
Customer succeeded to **bring up in 2 weeks** based on delivered IP package & SDK



### Use Case #2

Multi-core:

Supported two modes (**real-time & application**), including IDU, bus matrix, etc.



## Nuclei IDE

Eclipse CDT Based development environment,  
easy hands on with manual.

- Nuclei RISC-V GCC, OpenOCD and QEMU integrated
- Nuclei Package(NPK) software solution
- Support SoC Subsystem SDK one-click import
- Portable executables, without installation
- One-click project template
- One-click project configuration
- In system debugging and programming
- Integrated serial port tool
- Real time register display
- Support Linux and Windows



## N300 Series Has Been Deployed to Various Applications



AIoT



Communication



Storage



MCU



Connectivity



GNSS