WHAT CAN YOU BUILD WITH A 1W 64-BIT ARM®V8 SOC

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SECURE CONNECTIONS FOR A SMARTER WORLD

AGENDA

- What are the Macro Trends Impacting Data Communications Applications?
- Layerscape LS1012A Overview
- New Use Cases
- Enablement – boards & software
- Security
- Example Applications

The World is Going Gigabit

Big Data analysis
and cognitive computing will enable us to interpret every bit of data

350 million photos
uploaded to Facebook every day

30 billion devices
connected to the internet by 2020

More than 300 hours of video
uploaded to YouTube every minute

Sources: Facebook and YouTube

Trends from the Edge (of the IoT)

IoT Brings an Enormous Security Challenge

- Everything is susceptible to security breaches – from Point of Sale to baby monitors

Need Fast Access to Data on the Go

- Even battery-powered applications need high throughput
- Portable devices and data centers are both power- and space-constrained applications

Answering the Challenge of the Edge (of the IoT)

Growth of the IoT will be limited, unless…

We can meet the challenge with a solution which combines:

- Line-rate networking performance
- Scalable 64-bit processing
- Hardware security

As well as:

- Low power consumption, and
- Ultra-small form-factor

New Applications Made Possible With the LS1012A

Better home automation & security

Higher performance, battery-backed aggregation

Portable Wireless Storage

On the go access to Terabytes of data

Mobile Wi-Fi routers

Enable gigabit-class portable Wi-Fi

Industrial IoT

Making high-speed low-power networks pervasive

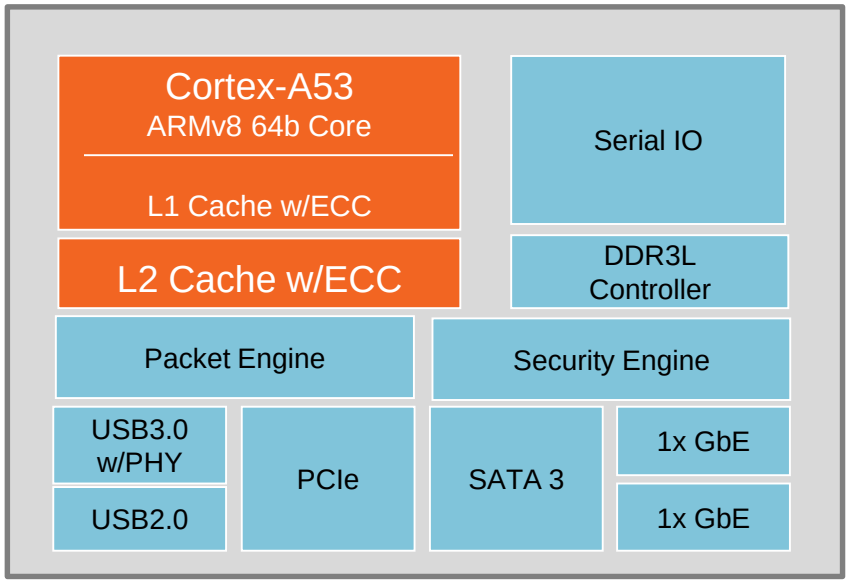
Introducing the Layerscape LS1012A Processor

World's Smallest and Lowest-power 64-bit Processor

- 800MHz ARM® Cortex®-A53 core
- Hardware packet accelerator for line-rate networking
- Networking-grade security
- Tiny package measures just 9.6mm on a side
- Typical power consumption of only 1W

Layerscape LS1012A Key Features

- 64-bit ARM Cortex-A53 core **running up to 800MHz**
- Over **2,000 CoreMark®** of performance at **1W (typical)** power dissipation
- Hardware **Packet Forwarding Engine** for acceleration of **IP packet processing** and reduced CPU load and power consumption
- **Trust and Security acceleration** enables hardware root of trust, high performance encryption & key life-cycle management
- Integrated peripherals include **USB 3.0 with integrated PHY, PCIe, 2.5 Gigabit Ethernet and SATA3** to reduce system costs
- Enables customers to implement **scalable product families** from single to multi-core leveraging a **common 64-bit software platform**
- Supported by **general-purpose SDK** as well as optimized **application-specific software solution kits**



Enablement to Help to Speed Time-to-Market

- **Feature-rich reference design board** for customer evaluation and proof of concept
- **Software Development Kit (SDK)** – rich Linux development environment
  - Enables General Applications Including Industrial & Networking
- **Application Solution Kits (ASKs)** – based on OpenWRT
  - Vertically integrated solution speeds time-to-market
  - Optimized Linux-based software platforms with hardware accelerator
    - Broadband IoT Gateways & Routers
    - Networked Storage
- **Plus**… a variety of tools, boards and operating systems from **3rd party partners**

New Use Cases

LS1012A Success Story #1

Cost Reduction

Fast boot

Low Power Consumption

Power core for computation

Education / Consumer

Education / Consumer – High-End IR Touch Panel

Customer's Product

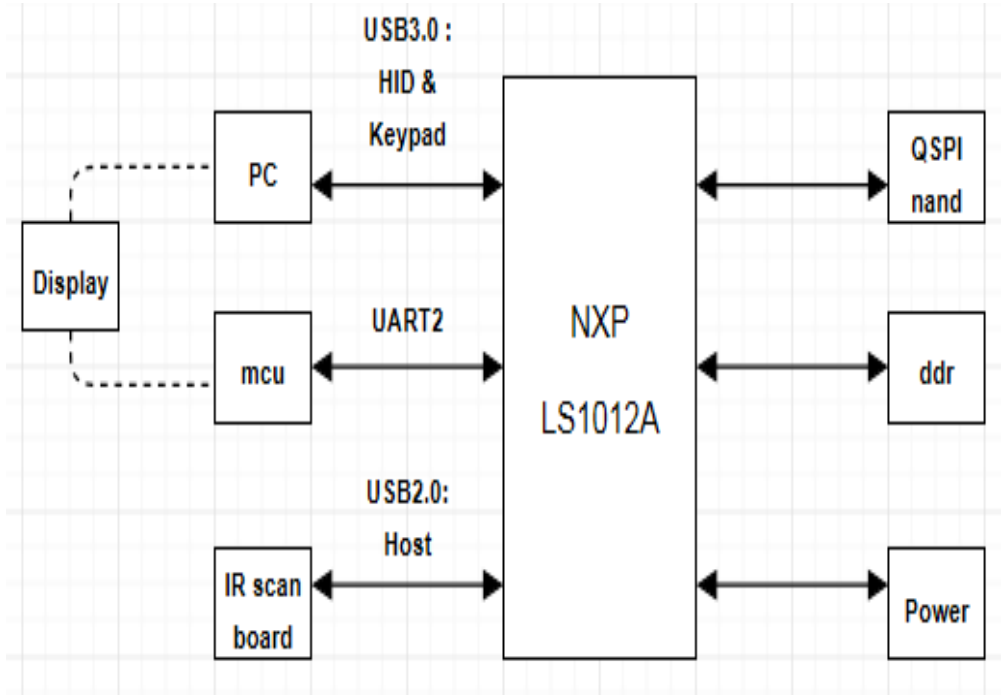
- High accurate touch and fluent writing performance touch sensor helps to improve human-machine interaction experience for smarter education in the classroom

Customer's Challenges

- Overall system requirement
  - Low-cost and low-power design
  - Multiple USB interfaces
  - Fast boot (64MB in less than 3 seconds) with low-cost serial NAND
  - Powerful core for computation

Education / Consumer – High-End IR Touch Panel

Block Diagram



NXP's Solutions

LS1012A

- Low-cost clocking and PMIC
- Supports high-performance serial NAND and NOR
- A53 core with ARM v8 architecture and NEON instructions
- 1 USB 3.0 and 1 USB 2.0 ports

LS1012A Success Story #2

Market Trends

Great wireless Throughput (> 2 Gbps)

Fast Time-to-Market

Low Power Consumption

Low cost

Consumer (Camera)

Consumer (Wireless File Transmitter for Camera)

Customer's Product

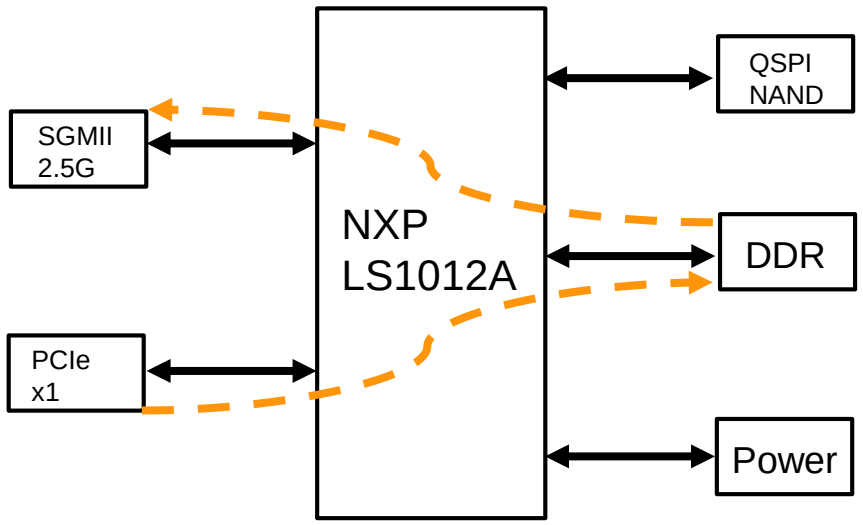
- Application is a data transmitter for DSLR/Camcorder. Recent high-end/Professional DSLR has a GbE port and customer also sells wireless transmitter as an option for Mid-range DSLR and Camcorder.
- LS1012A is used to transmit data from their ASIC (8K encoder) via PCIe to GbE or Wi-Fi

Customer's Challenges

- To achieve the highest throughput (PCIe to Ethernet) as possible. Customer wants to use 2.5GbE in LS1012A.
- Also low power and lower price is required. (Target is <1W)

Consumer (Wireless File Transmitter for Camera)

Block Diagram



NXP Solutions

LS1012A + Commercial SW and Service

- LS1012A networking performance at low cost and low power.
- Excellent data throughput between PCIe and GbE with LS1012A-RDB.
- Fast boot time on QSPI.

LS1012A Success Story #3

Market Trends

Rich interfaces to support various wireless and wired connections

Fast Time-to-Market

Low Power Consumption

Low cost

Consumer (High performance home wireless router w/ WiFi + LTE + Bluetooth)

Consumer (High Performance home wireless router w/ WiFi + LTE + Bluetooth)

Customer's Product

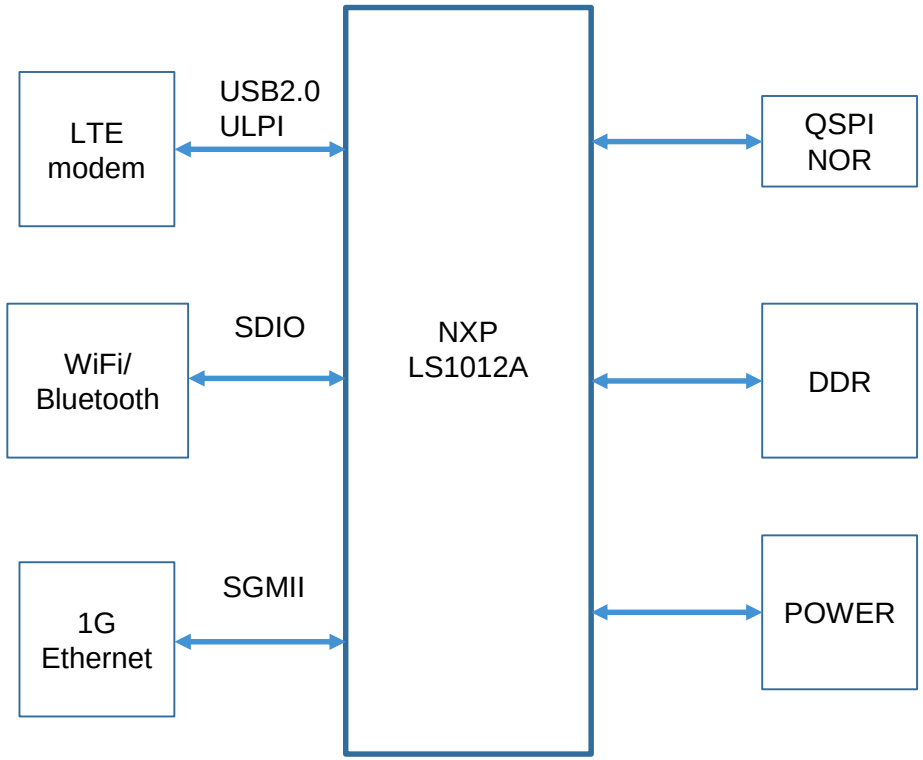
- Application is a wireless LTE router which can connect to LTE, WIFi, Bluetooth and GbE interfaces
- High performance and low latency is required for data transmission among different interfaces

Customer's Challenges

- High performance and fast time-to-market
- Also low power and low BOM cost

Consumer (High Performance home wireless router w/ WiFi + LTE + Bluetooth)

Block Diagram



NXP Solutions

LS1012A + Commercial SW and Service

- LS1012A supports fast data transmission from one interface to the other.
- NXP Gateway ASK (based on popular OpenWRT) which is production ready SW with high performance to enable quick time-to-market

LS1012A Success Story #3

Market Trends

Gigabit Ethernet throughput (2x Gb Ethernet Controllers)

Fast Time-to-Market

Low Power Consumption – Small Size

Low cost

Secure IoT Gateway

Secure IoT Gateway

Customer's Product

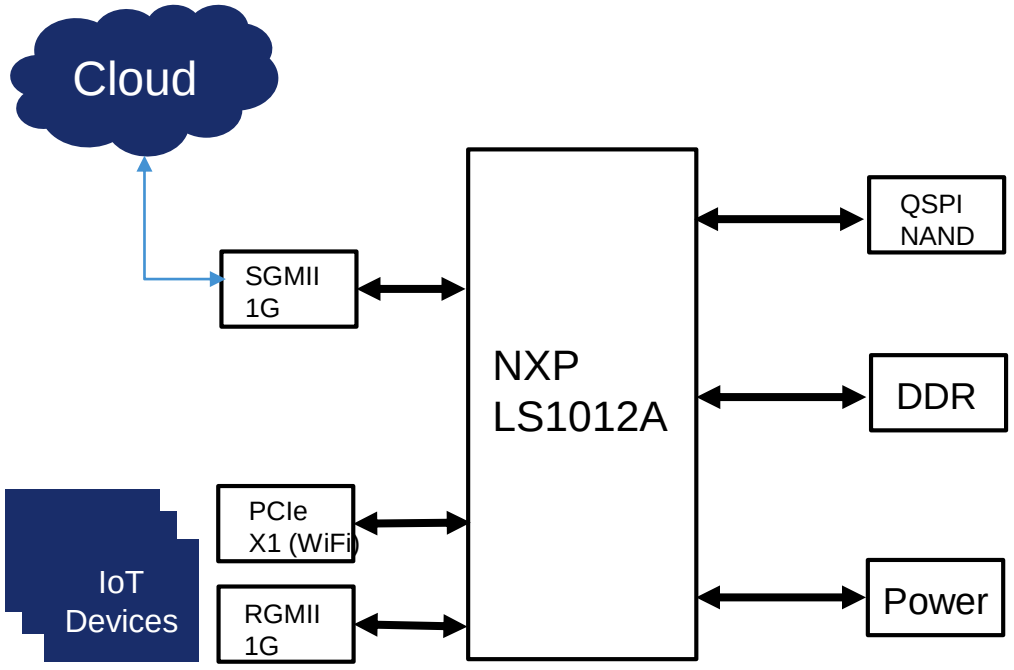
- Application is a "zero-touch" IoT gateway that provides secure links between cloud systems and the IoT Edge devices
- LS1012A provides secure tunnels to the cloud from connected local devices (wireless or wired)

Customer's Challenges

- To provide high speed encrypted pipes to multiple cloud providers
- Also low power and lower price is required. (Target is <1W)

Secure IoT Gateway

Block Diagram

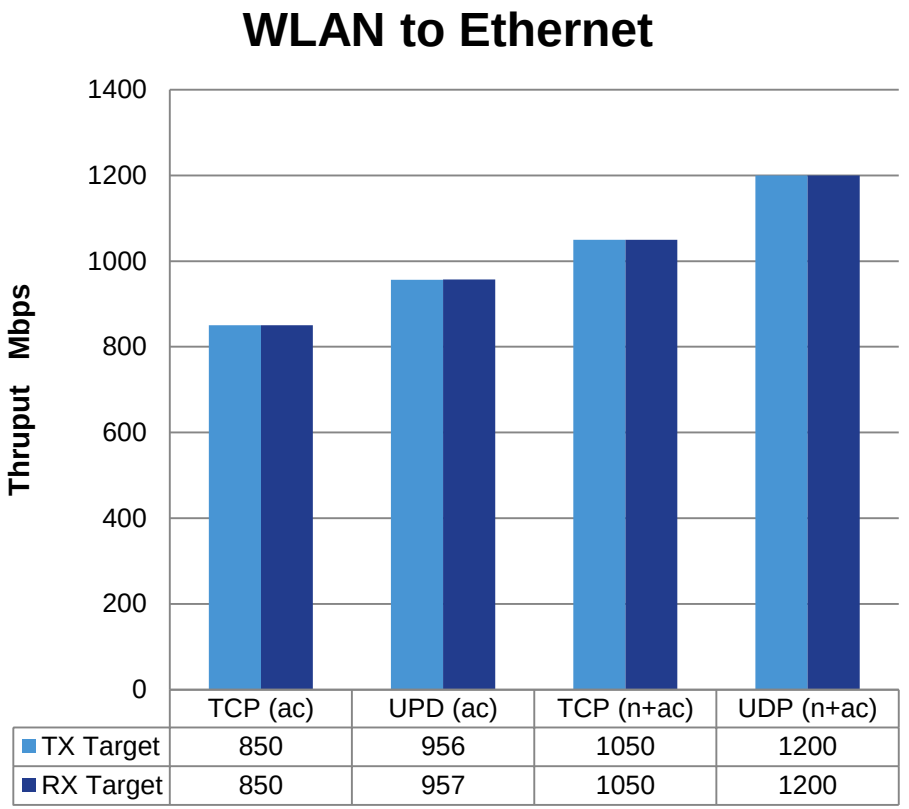


NXP Solutions

- LS1012 provide superior value and power efficiency (<1 W power consumption)
- Strong Linux support with SDK, which aids in development of Linux based networking
- LS1012A-RDB

LS1012A Packet Forwarding Engine - Performance Estimates

Ethernet to Ethernet: NAT Routing			
Frame Size	Bi-dir thruput (IPV4) – Mbps	Bi-dir thruput (IPV6) - Mbps	CPU utilization target
64	2000	2000	<5%
128	2000	2000	<5%
256	2000	2000	<5%
512	2000	2000	<5%
1024	2000	2000	<5%
1280	2000	2000	<5%
1518	2000	2000	<5%



- NAT routing targets achieved with minimal CPU impact for IPV4/6 acceleration

Initial test results for 802.11ad 60GHz Radio (QCA6500)

- Traffic generator: iPerf
- Packet Size: 1500 MTU, TCP
- Performance data for wireless OTA
- LS1012A at 800Mhz.

- **Test Setup :**

wireless

- X86 machine (AP) <----------> LS1012ARDB (STA)

- **Performance Numbers :**

Traffic flow	Throughput (Gbps)	LS1012ARDB CPU
Uplink	1.68	99%
Downlink	1.16	99%
Bi-directional	1.3	99%

- **Test Setup :**

wireless

- X86 machine (STA) <----------> LS1012ARDB (AP)

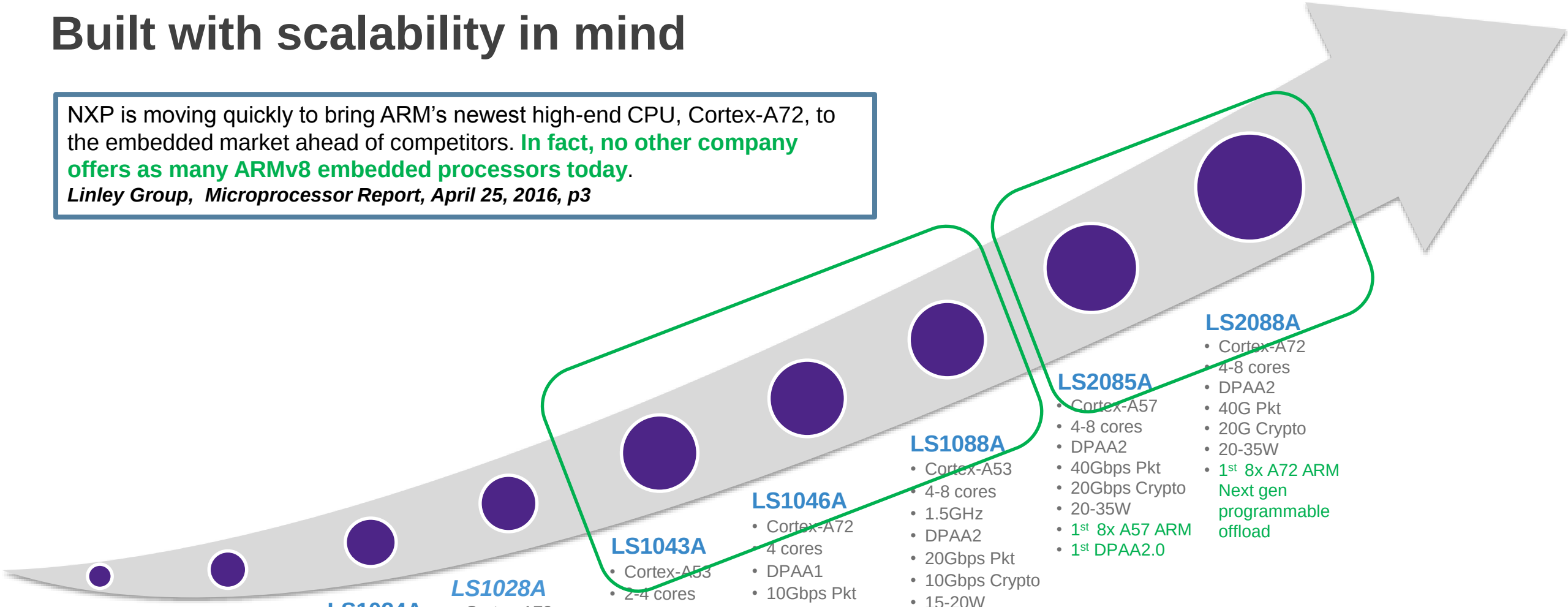
- **Performance Numbers :**

Traffic flow	Throughput (Gbps)	LS1012ARDB CPU
Uplink	1.15	99%
Downlink	1.6	98%
Bi-directional	1.38	99%

Built with scalability in mind

NXP is moving quickly to bring ARM's newest high-end CPU, Cortex-A72, to the embedded market ahead of competitors. **In fact, no other company offers as many ARMv8 embedded processors today**.

Linley Group, Microprocessor Report, April 25, 2016, p3



LS1012A
- Cortex-A53
- 800MHz
- 2Gbps Packet
- 1Gbps Crypto
- 1-2W
- Lowest power 64-bit ARM

LS1021A
- Cortex-A7
- 2 cores
- 1GHz
- 2Gbps Pkt
- 1Gbps Crypto
- 2W

LS1024A
- Cortex-A9
- 2 cores
- 1.2GHz
- 2Gbps Pkt
- 2Gbps Crypto
- 3-5W

LS1028A
- *Cortex-A72*
- *2 cores*
- *5Gbps Pkt*
- *5Gbps Crypto*
- 4-9W
- *1st with TSN switch*
- *Integrated GPU*

LS1043A
- Cortex-A53
- 2-4 cores
- 10Gbps Pkt
- 5Gbps Crypto
- 5-10W
- 1st 64-bit ARM processor for gateways and access points

LS1046A
- Cortex-A72
- 4 cores
- DPAA1
- 10Gbps Pkt
- 10Gbps Crypto
- 10-12W
- 1st Value Tier A72 ARM for gateways and routers

LS1088A
- Cortex-A53
- 4-8 cores
- 1.5GHz
- DPAA2
- 20Gbps Pkt
- 10Gbps Crypto
- 15-20W
- 1st 8x A53 ARM Next gen programmable offload

LS2085A
- Cortex-A57
- 4-8 cores
- DPAA2
- 40Gbps Pkt
- 20Gbps Crypto
- 20-35W
- 1st 8x A57 ARM
- 1st DPAA2.0

LS2088A
- Cortex-A72
- 4-8 cores
- DPAA2
- 40G Pkt
- 20G Crypto
- 20-35W
- 1st 8x A72 ARM Next gen programmable offload

Pin Compatible

Silicon and Software Provide the Solutions our Customer Require

Multicore Processors

- 35W — LS2088
- LS2080
- LS1088
- LS1046
- LS1043
- LS1021
- 1W — LS1012


Smart Home


IOT Gateway


High-End GW


Retail Router


Services Routers


Carrier WAP


Enterprise WAP


Wi-Fi Extender


vE-CPE


vCPE


SD-WAN Access Node

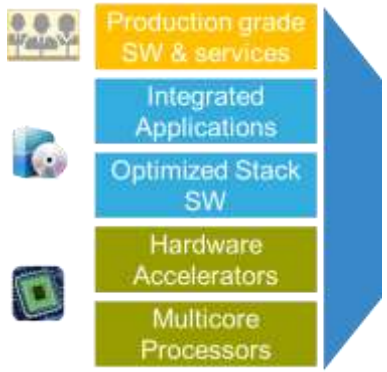

100Gbps Services Switch


25Gbps Services Switch


NFV infrastructure


Roadside Infrastructure

Solutions deployed by ODM and OEM partners



Software Platforms

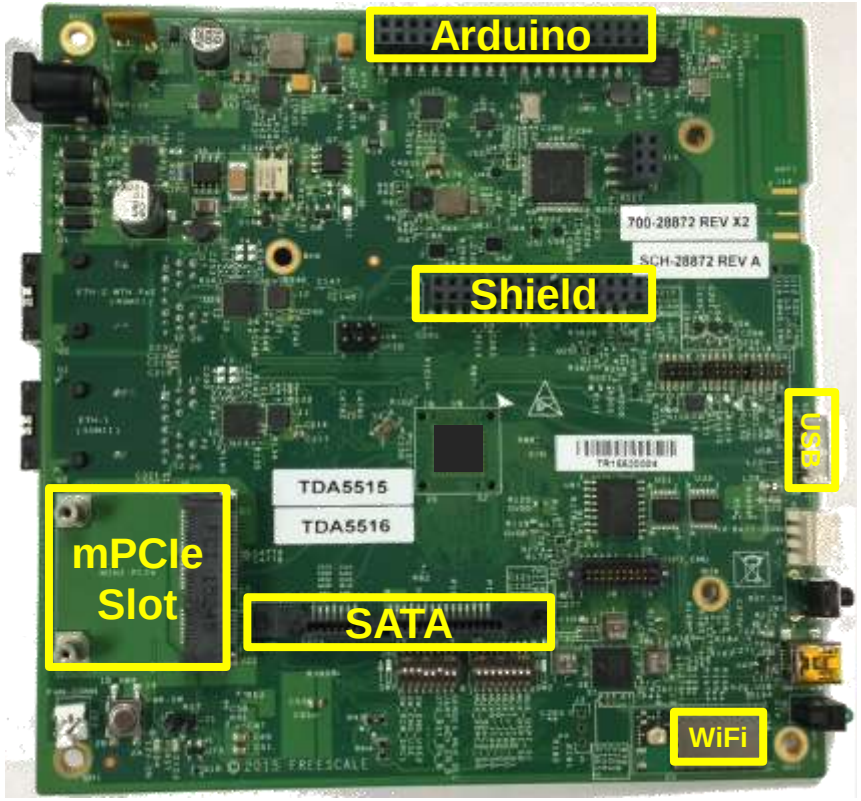
IOT & Home | GW | WLAN | vCPE | Switch | NFV | ITS

Enablement Software

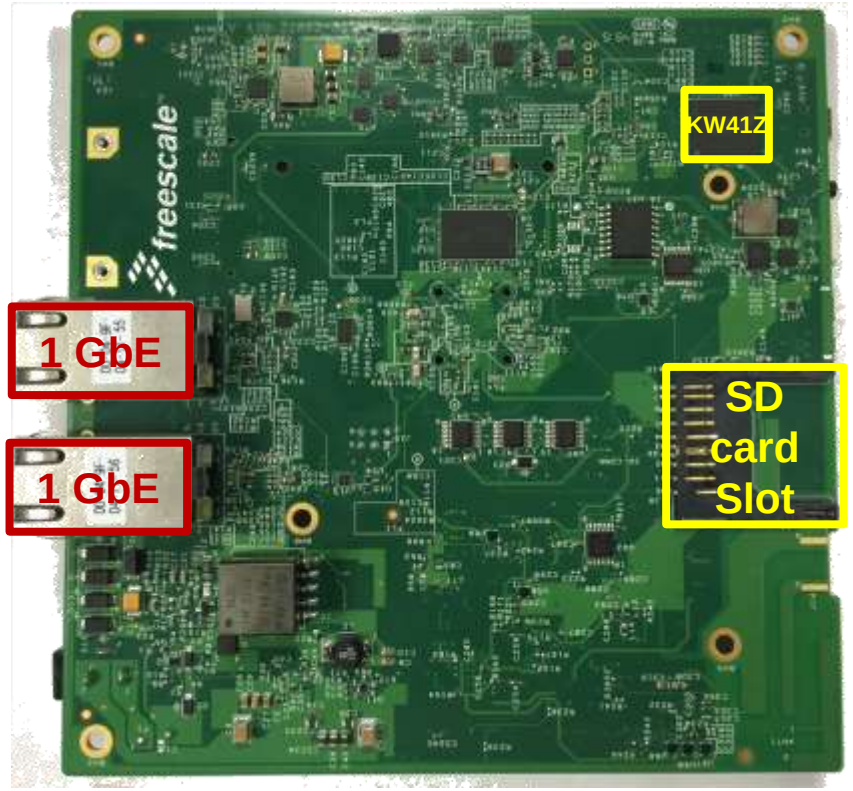
Secure Embedded & Enterprise Linux Distributions

LS1012A Enablement

LS1012A-RDB



Top side

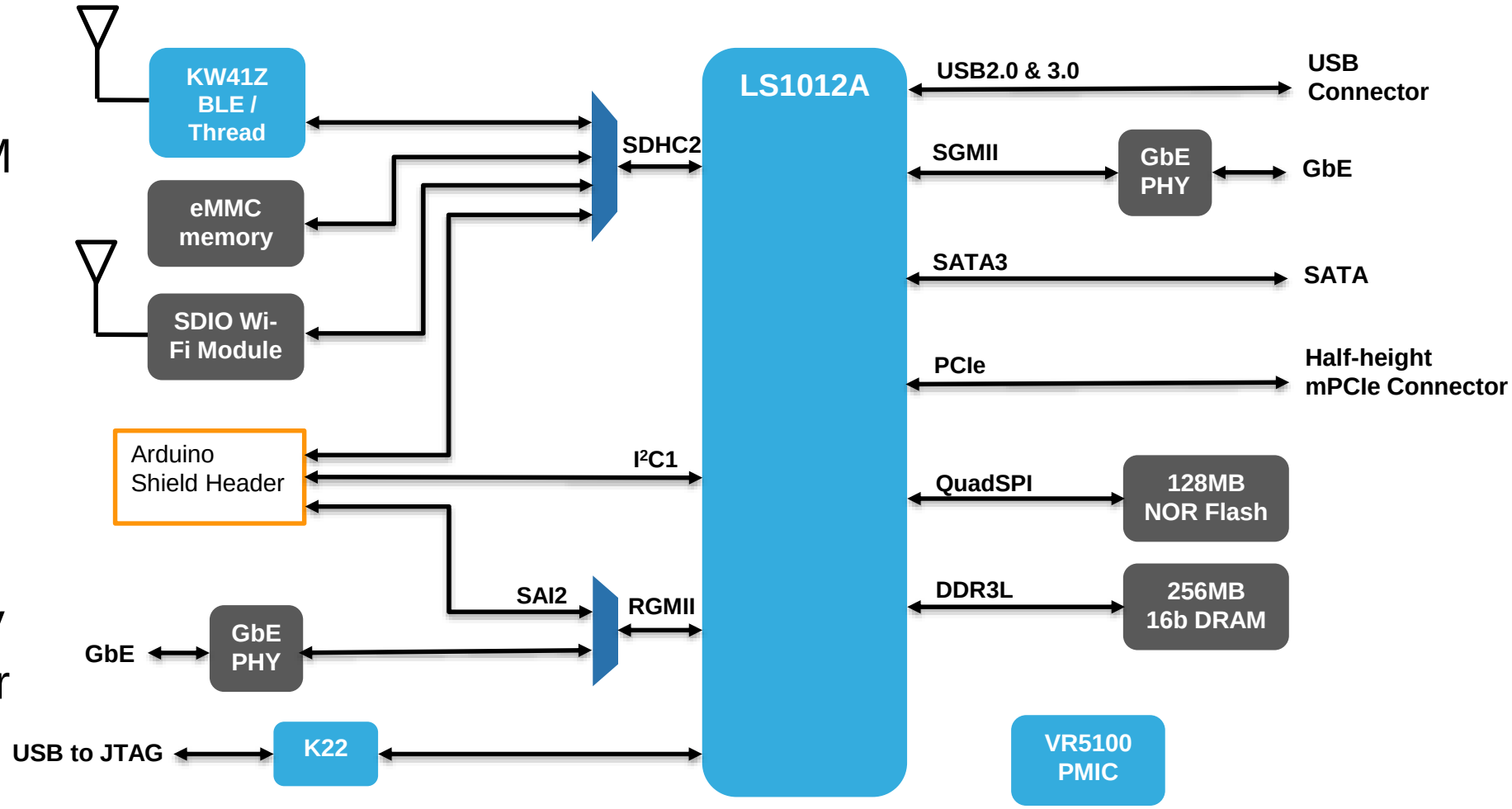


Bottom side

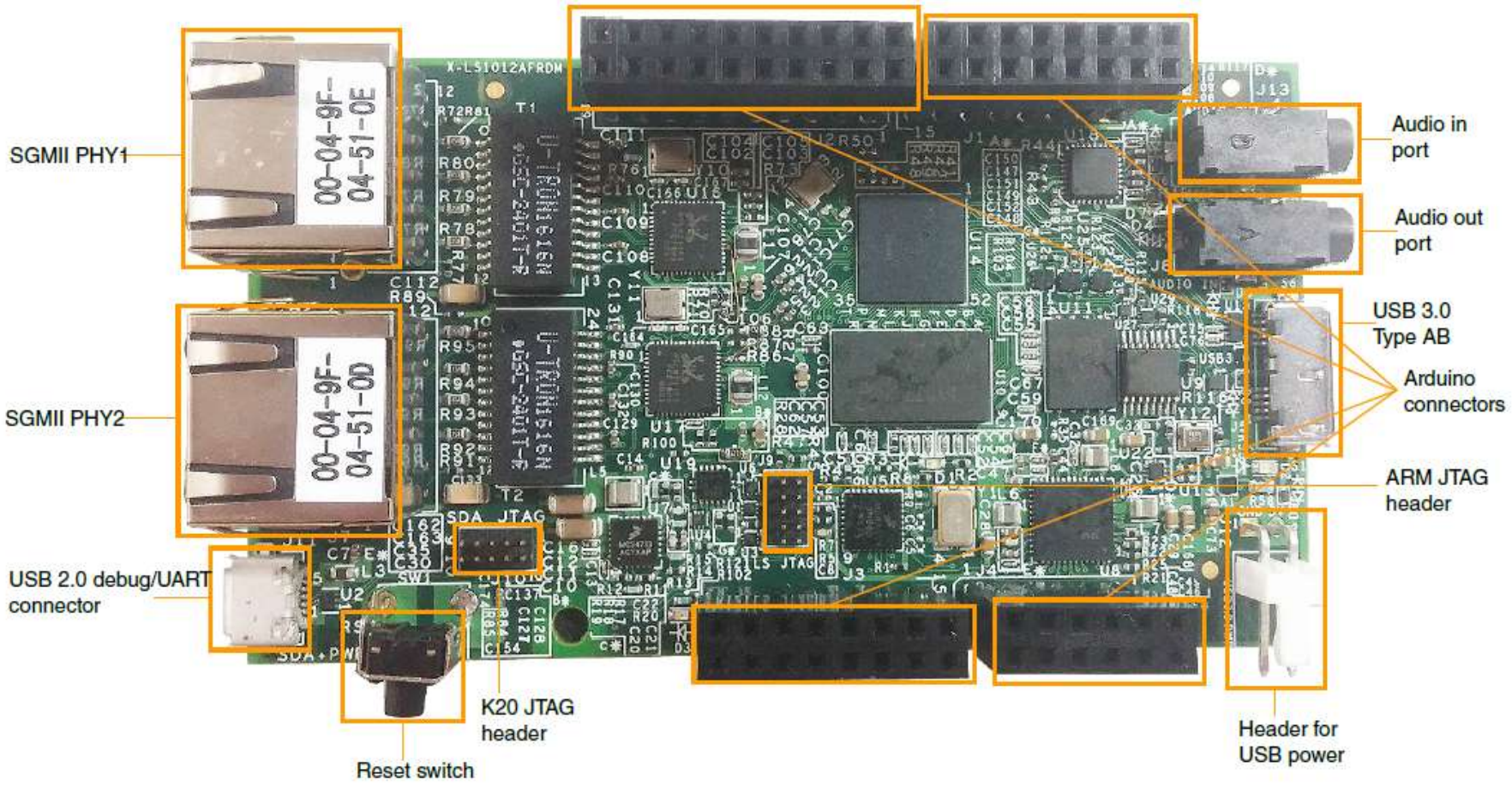
LS1012A-RDB board

Features

- 128MB NOR Flash
- 256MB DDR3L DRAM
- 2x GbE
- 1x mPCIe
- 1x SATA
- USB3.0
- USB2.0
- KW41Z 2.4GHz radio supports Thread & Bluetooth Low Energy
- Arduino Shield header for expansion
- SDIO Wi-Fi
- SW support for NFC



FRDM-LS1012A board – get started with Layerscape for $49.95



Key features

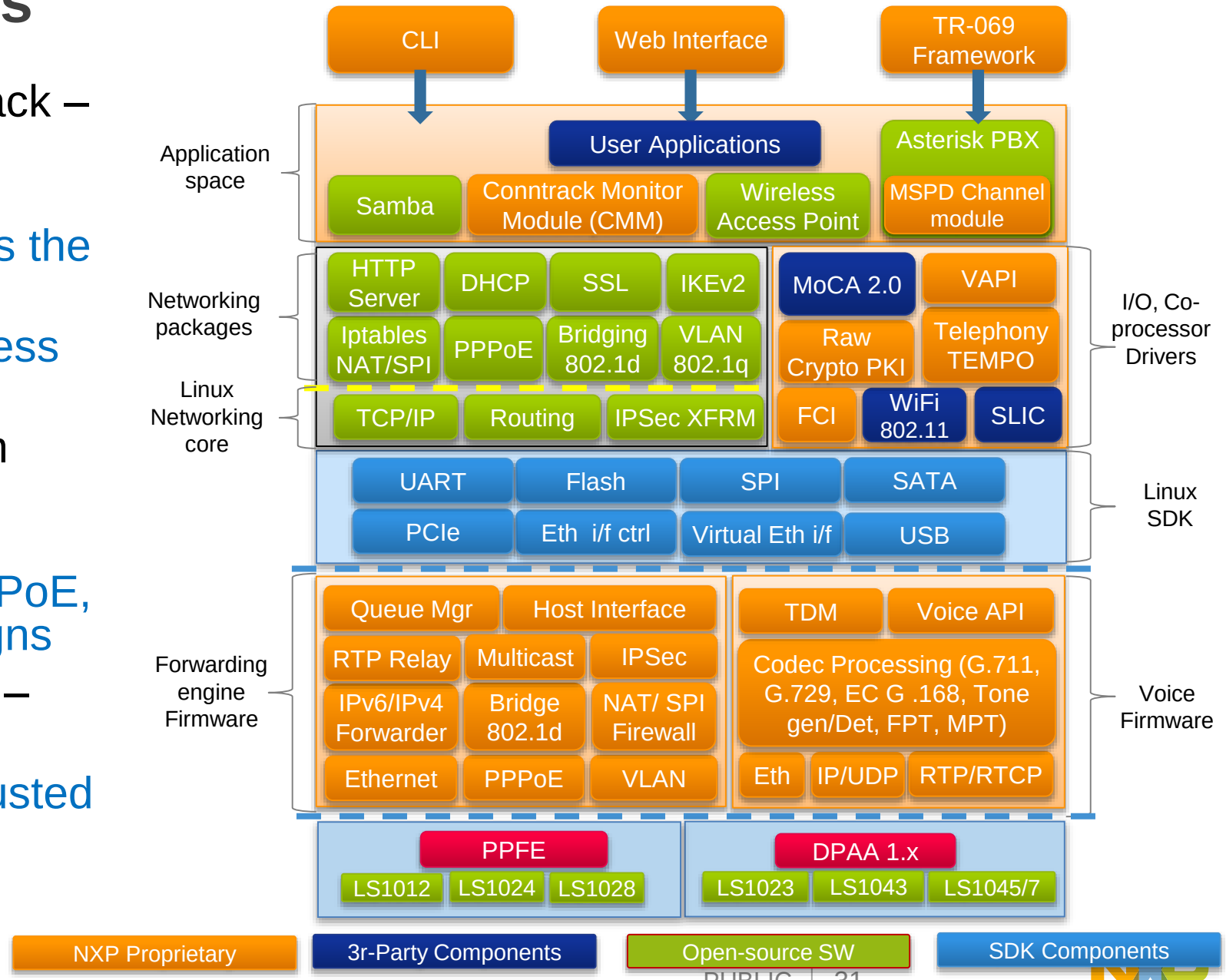
- Credit-card size
- 4-layer PCB
- USB-powered
- 2x GbE
- 1x USB3.0 OTG
- Arduino Expansion header:
  - SPI
  - I2C
  - UART
  - GPIO
- Headphone output
- Microphone input
- Layerscape SDK

LS1012A Software Offering

Software Platform	Description	Pricing	Enables
QorIQ SDK (Yocto-based)	• General-purpose Linux SDK, supporting all QorIQ processors • Yocto build environment	• Free of charge	• Scalable networking, industrial and consumer applications • Migration from older QorIQ devices
Layerscape SDK (Ubuntu-based)	• General-purpose Linux SDK, support for Linux distributions • Ubuntu user space packages	• Free of charge	• Fast development with prebuilt packages • Expanded application space
Application Solution Kit (BHR)	• Optimized Linux networking solution with hardware packet acceleration • OpenWRT build environment	• $10,000 for source code • Binary image free of charge	High performance and fast time to market for broadband networking applications such as gateways & routers
Application Solution Kit (NAS)	• Optimized Linux networking solution with hardware packet acceleration • OpenWRT build environment	• $10,000 for source code • Binary image free of charge	High performance and fast time to market for consumer network attached storage & other HDD or SSD based applications

Gateway ASK Highlights

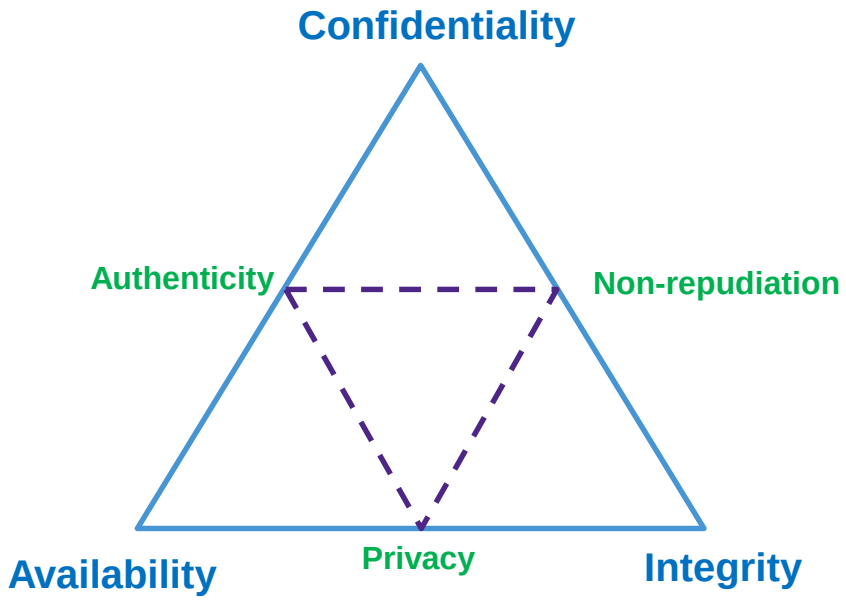
- Turn key & mature software stack – Over 10M deployed
- Highly optimized & feature rich Network stack – Fully leverages the HW Accelerators
- Wire speed performance with less than 5% CPU load
- Full suite of network application packages for variety of market needs
- Low power envelope. Ideal for PoE, PoE+ or battery operated designs
- High performance SEC engine – Gigabit Encryption
- HW security – Secure boot, Trusted environment



Addressing security

Security Fundamentals

- **Confidentiality** – data is only disclosed to authorized parties
- **Integrity** – data is trusted
- **Availability** – data is accessible when and where needed
- **Non-repudiation** – a trusted audit trail is provided
- **Authenticity** – node's identity can be verified
- **Privacy** – service does not automatically see customer data



Critical Security Roles of the Gateway Layer

- **Provide an isolating layer between cloud layer and device layer**
  - Assume all IoT Devices are potentially compromised
  - IoT devices cannot gain access to cryptographic secrets from other devices or layers

- **Classification-based control**
  - IoT devices are only allowed to send / receive data that is appropriate to the class of device
    - For example:
      - An occupancy sensor should not be trying to browse the web
      - A factory robot should only connect to the company cloud via VPN

- **Managing Quality of Service (QoS)**
  - Ensure connections do not “hog” all bandwidth
  - Critical messages must get through

Security Requirements for Gateways & other IoT applications

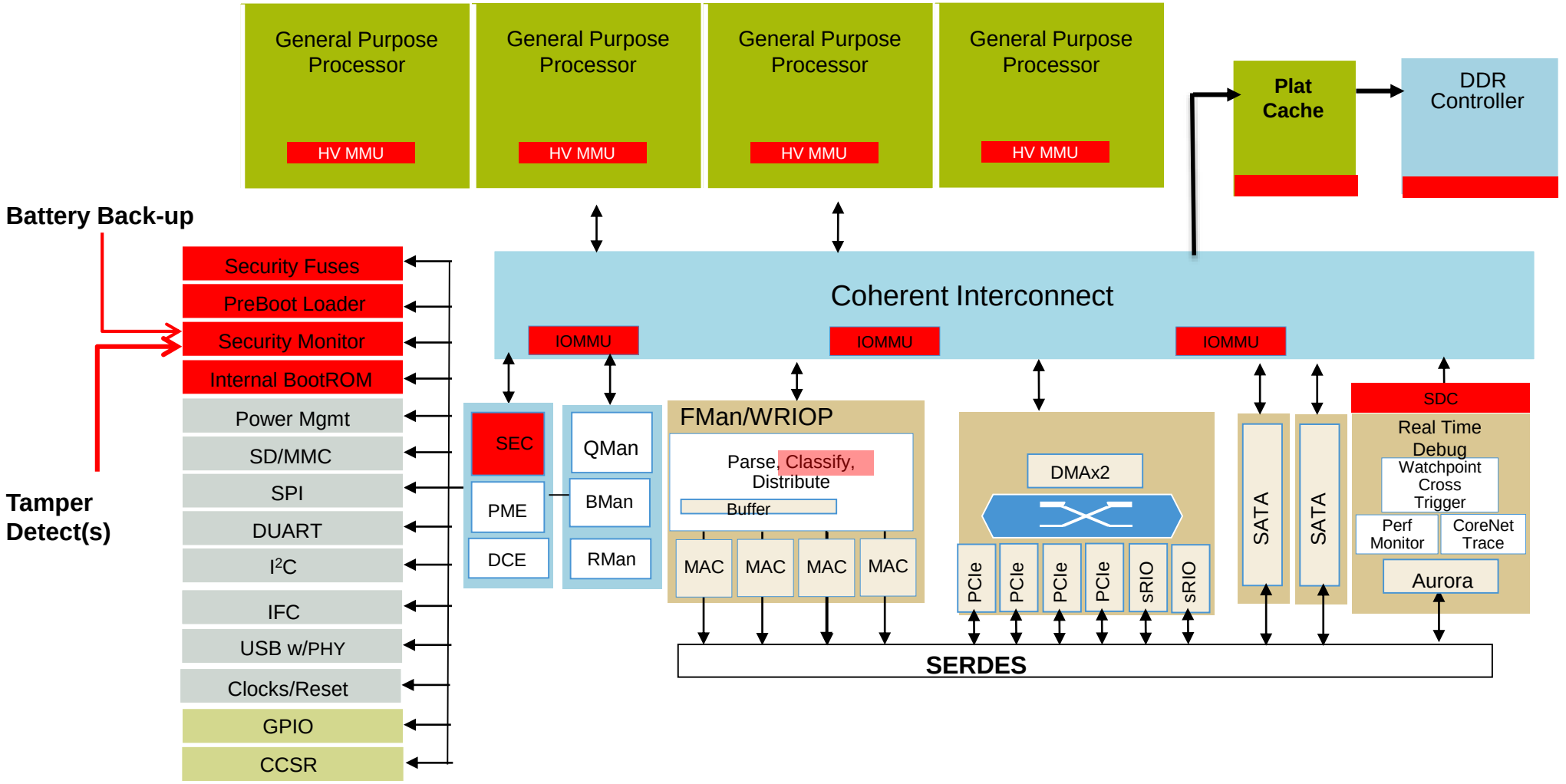
- **Cryptographic acceleration**
  - Symmetric & asymmetric crypto
  - Random number generation
  - Protocol acceleration

- **Lifecycle management of cryptographic keys**
  - Provisioning
  - Storage
  - Operation
  - Revocation / Destruction

- **Hardware root of trust**
  - Secure boot, secure debug, etc.

- **Virtualization support**
  - Isolate applications and dataflows

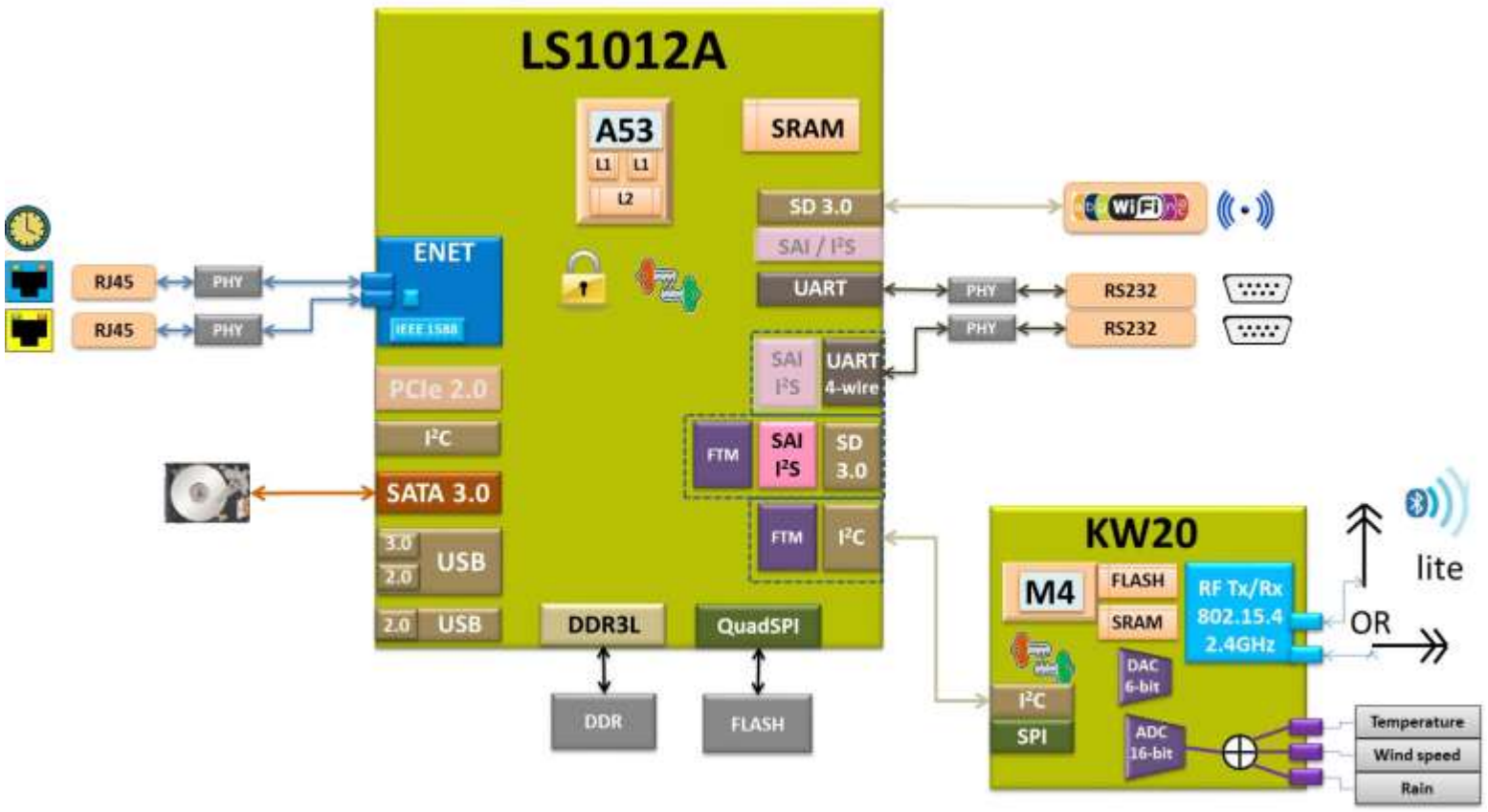
Layerscape Trust Architecture – Features Supporting Gateway Security



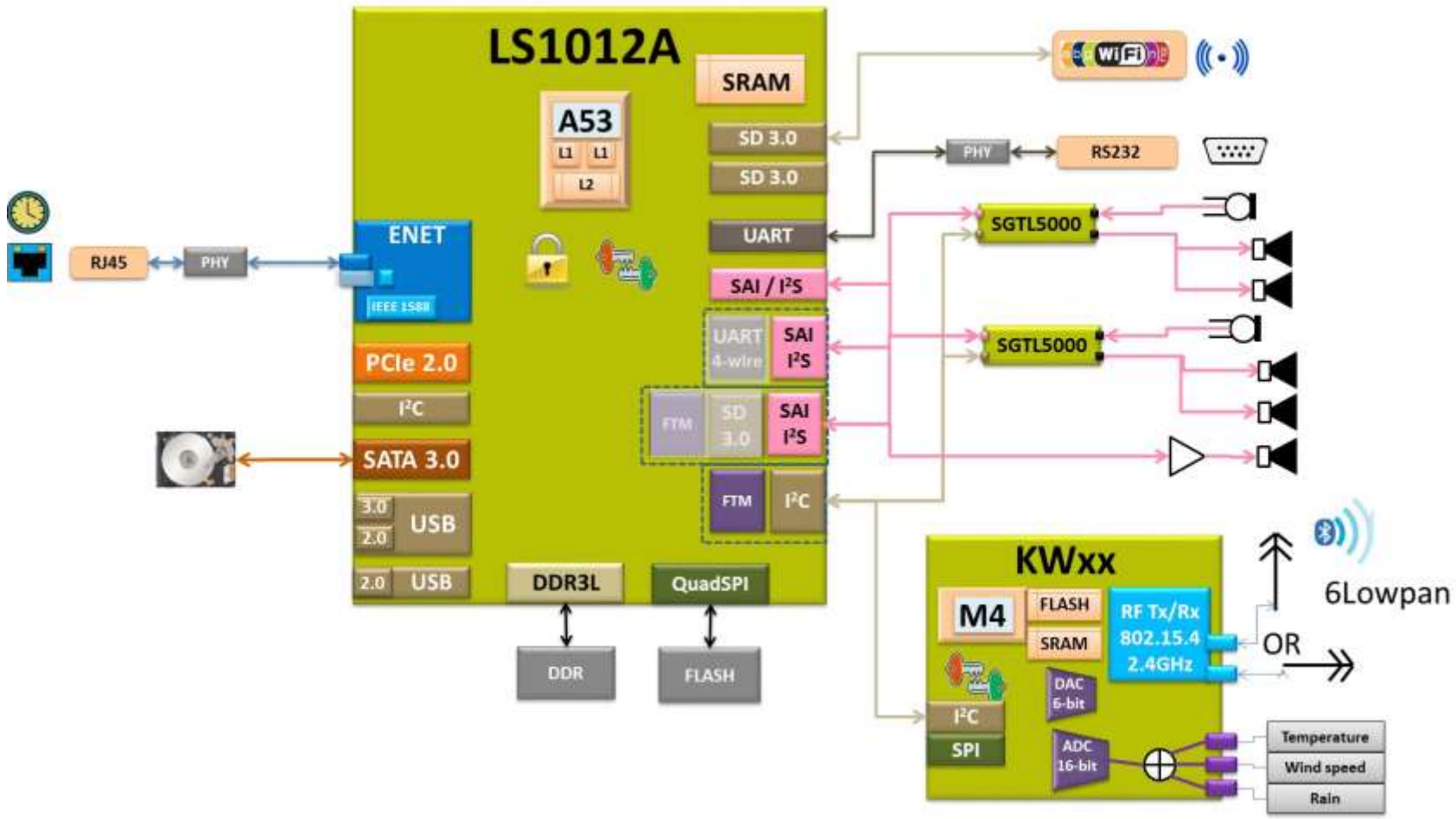
Use Case Examples

IOT Gateway Use Case

Value IOT Gateway

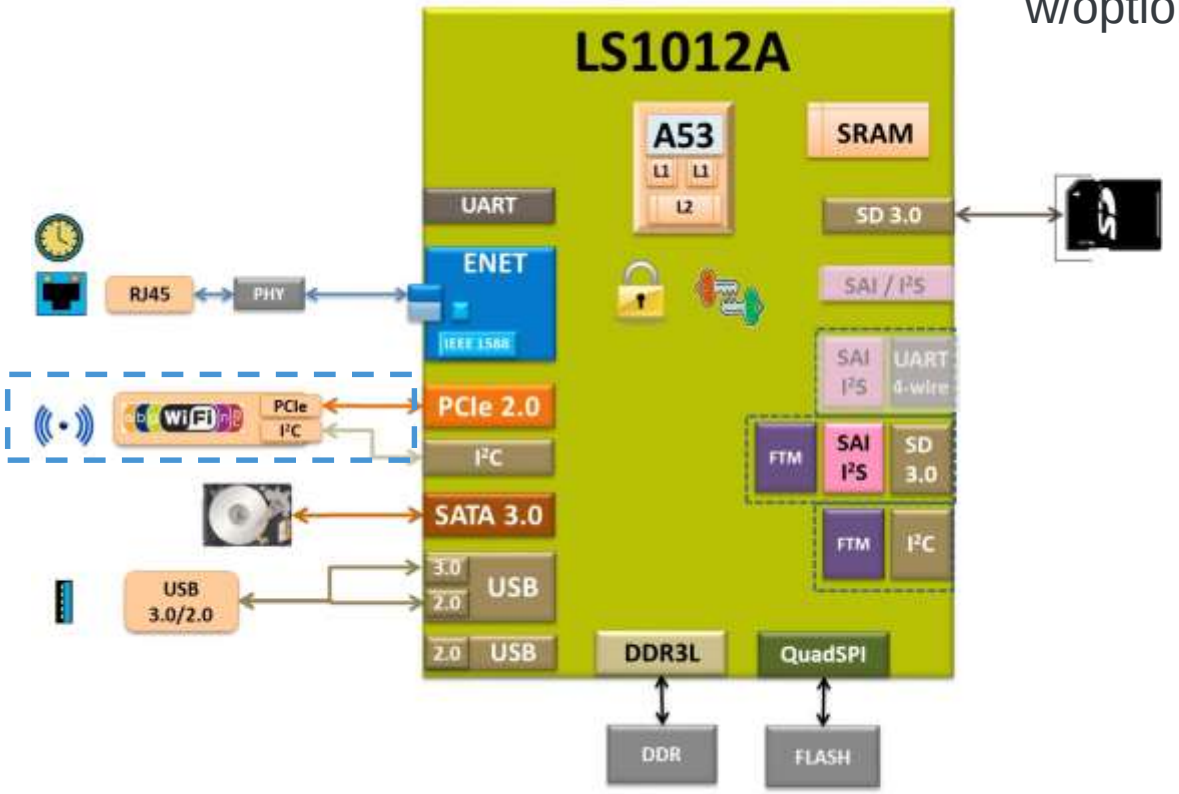


Value IoT Gateway with Audio Networking

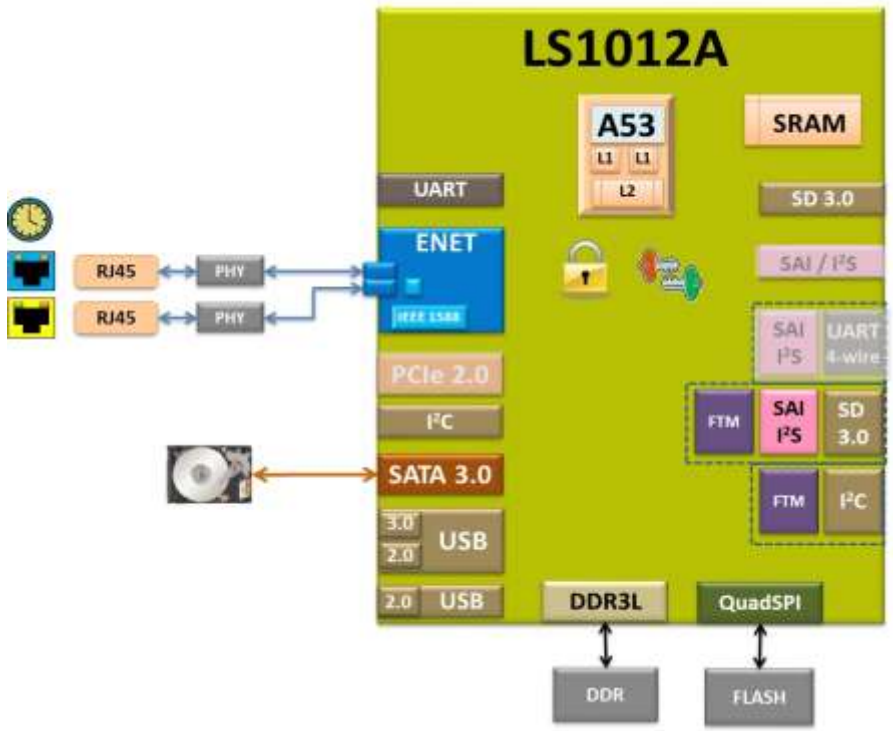


Consumer NAS/DAS Use Case

Consumer NAS/DAS
w/optional Wi-Fi

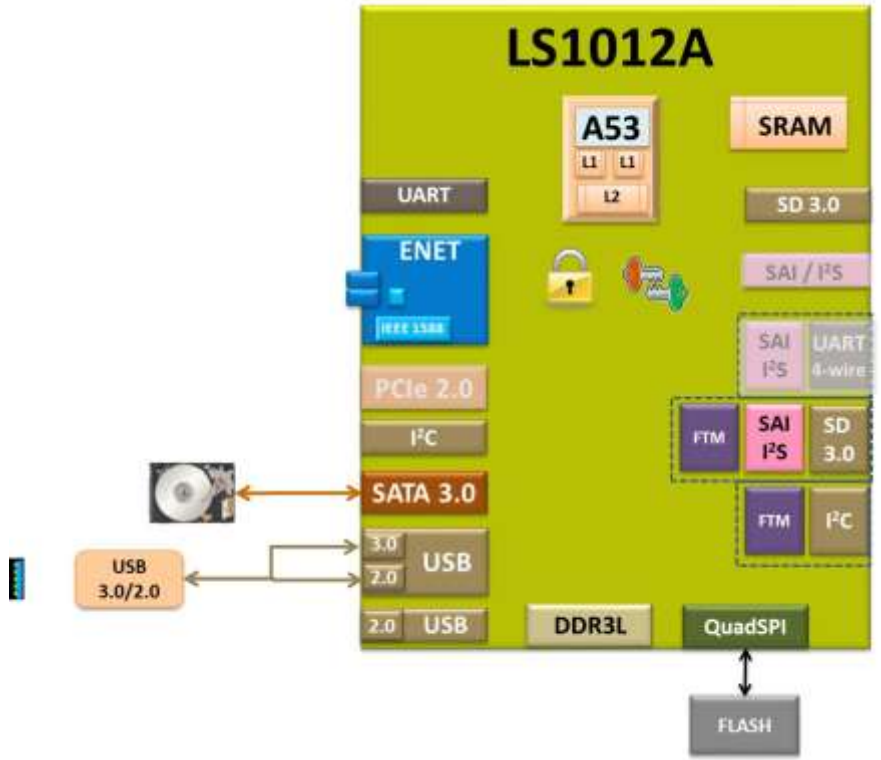


Ethernet Drive and USB to SATA DAS Use Cases

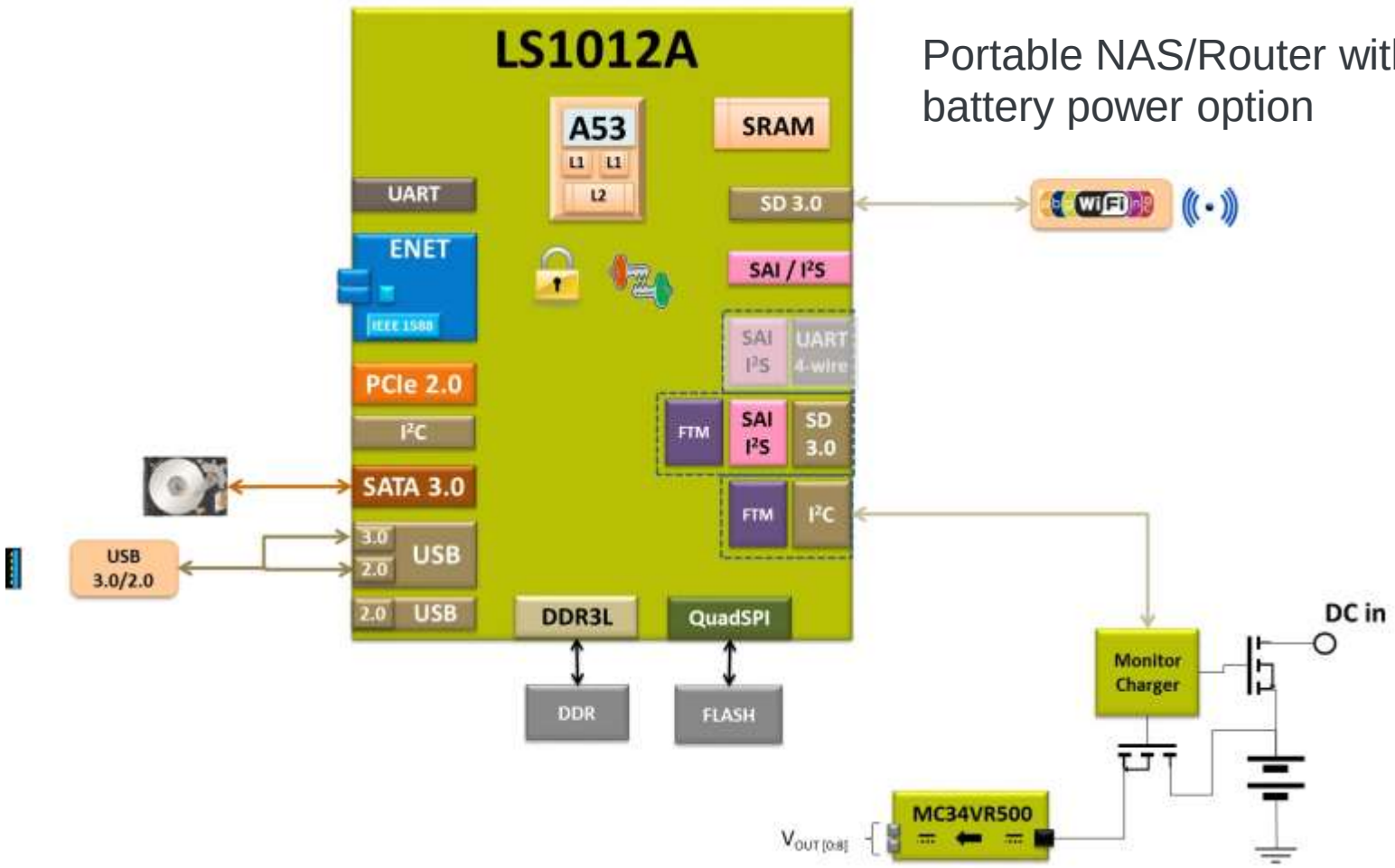


Ethernet Drive

USB to SATA Bridge



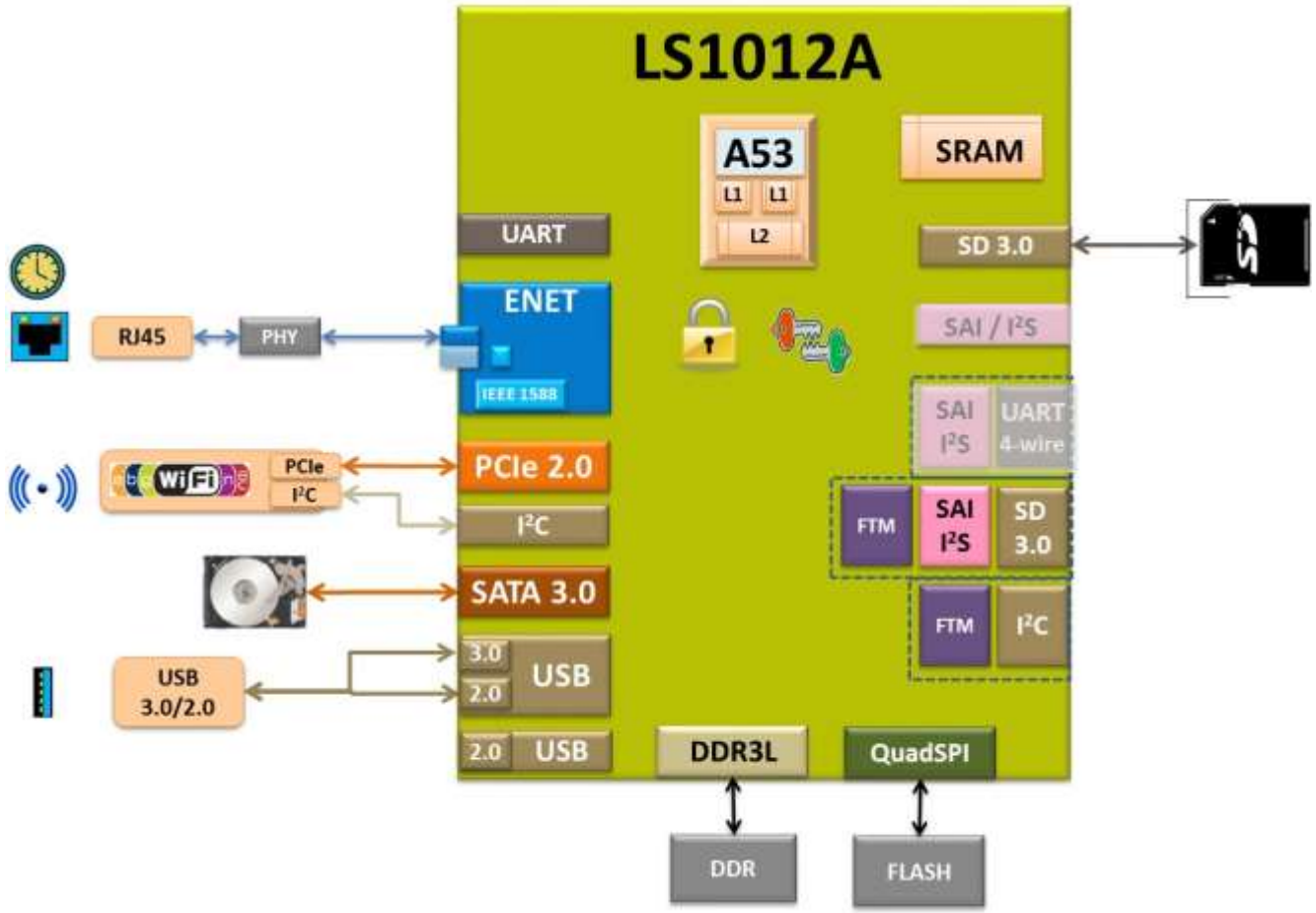
Battery Powered Portable NAS Use Case



Portable NAS/Router with battery power option

BB Ethernet Gateway Use Case

Entry BB Ethernet Gateway



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FOR A SMARTER WORLD