Edge Computing With Layerscape

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TECHNOLOGY DAYS

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Agenda

- Edge Computing Introduction
- Layerscape Processors
- Layerscape Software and EdgeScale
- Edge Computing Applications
- Conclusion



Edge Computing Definition

- Inclusive
 - Computing near the source/sink of data
 - -AKA moving computing to the data
- Narrow
 - Applying cloud-computing techniques outside the data center
 - Soft provisioning of compute, storage, networking
 - Virtualization and containerization
 - Service-oriented architecture
 - Orchestration



Related Concepts

- Fog
 - For fog adherents, fog nodes are capable participating in distributed analytics
 - NXP does not distinguish between fog and edge
- Hybrid cloud
 - An IT term describing linking private and public clouds
 - Analogous to edge computing but unrelated
- Embedded processing
 - General term for computing done in a system without user-loaded software
- Internet of Things (IOT)
 - Narrow: embedded systems with internet connections
 - Expansive: any system or device accessible directly or indirectly via the internet
 - Complements edge computing



Edge Computing Is On Premises or in the Network





Edge Computing Evolutionary Stages

1. Precursor

Local

Command

and Control

P





3. Re-Localization

4. Local Cloud



Cloud APIs Implemented Locally

Pre-Edge Computing

True Edge Computing



Edge Computing Topologies



- Dimension 2: Computational Topology
- Self-contained: Edge node does all computation for a specific machine or IoT endpoint
- Hub and spoke: One edge node services multiple machines/endpoint
- Peer-to-peer: Loads migrate among nodes with free capacity or the cloud
- Hierarchical: Edge node shares computation, example:
 - Cloud trains models
 - Endpoint classifies observations (e.g., recognizes objects)
 - Edge node decides on actions



Edge Computing Advantages Over Cloud Computing

Reduce Data Transferred



Reduce Latency



Secure Data Onsite





Edge (and Cloud) Computing Advantages Vs Traditional Embedded



Major Edge Computing Players

OEMs/ODMs



Consumers & Businesses

Complications



Ecosystem

Abstract programming and deployment models demand a standard platform



Manageability

Cloud frameworks help manage applications, but what about far-flung devices?



Security

Edge nodes must not be recruited to a thingbot army



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A Broad and Scalable Edge Computing Portfolio



- All LS-series processors have rich set of IO USB, PCIE, SATA, GPIO, I2C, SPI, UART
- All support Trust Architecture for platform security
- Support both embedded and PC Linux distros
- Support industrial temperature ranges
- Support long lifecycles



arm

One Package, Four SoC Options

Arm Cortex-A72 Doubles Performance Vs Cortex-A53



4x A72 1.8 GHz 8.5 W Typical 45,330 Coremark Per core SpecINT Per core SpecFP

2xA721.2 GHz 5.6 W Typical 15,000 Coremark Per core SpecINT Per core SpecFP

Detailed Example:

LS1028A Processor With Dual Arm Cortex-A72

Security	Core Complex					
Security Engine ARM Trust Zone	ARM	ARM Cortex –A72		16/32-bit DDR3L/4 Memory Controller		
Secure Boot	Cortex –A72					
Power Management	48 KB L1-I 32 KB L1-D	48 KB L1-I 32 KB L1-D				
Standard interfaces						
2x SD/SDIO/eMMC	1MB L2 - Cache					
3x SPI	Coherent Interconnect (CCI-400)					
2x UART, 6x LPUART	Accelerators and Memory		High Speed	interfaces	erfaces Networking Elements	
8x I2C, GPIO	Control					
6x SAI, 2x CAN-FD	256KB SRAM		PCle 3.0	SATA 3	witch	2.5 GbE
FlexSPI						2.5 GbE
8x Flex Timer				USB 3.0	TSN S	2.5 GbE
Multimedia interfaces	3D GPU		PCle 3.0	WFUT		2.5 GbE
4K LCD Controller				USB 3.0 w/PHY	2.5 TSN GbE	
eDP/DP Phy					1 GbE	

Target Applications:

- Industrial Control, PLCs, Gateways
- Automotive
- Professional Audio/Video

- IoT Gateways
- Human Machine Interface

Core complex

- 2x 64-bit Cortex-A72 with Neon SIMD engine
- Speed up to 1300 MHz
- Parity and ECC protected 48 KB L1 instruction and 32 KB L1 data cache
- 1 MB L2 cache with ECC protection

Basic peripheral and Interconnect

- 2x USB 3.0 OTG controllers with integrated PHY
- 2x eSDHC controllers supporting SD/SDIO 4.0
- 2x CAN-FD controllers
- 8x UART serial ports

Networking elements

- Four Port TSN Ethernet Switch up to 2.5 Gbps on each port
- Up to four SGMII supporting 1 Gbps
- Up to one USXGMII supporting 2.5 Gbps
- Up to one QSGMII
- Up to one RGMII
- 2x PCI Express Gen 3 controllers
- 1x SATA Gen 3.0 controller

Accelerators and Memory Control

- 1x 16/32-bit DDR3L/4 Controller with ECC support up to 1.6 GT/s
- Time Sensitive Networking (TSN) Ethernet Switch
- Security Engine (SEC)
- QorIQ Trust architecture: Secure boot, ARM Trust zone and security monitor Qualification
 - Commercial and extended temperature (support for 125C Tj)

Package

• 17x17mm, 0.75mm pitch FC-PBGA

Power

• 5W TDP





Trust Architecture

Hardware based security features to ease the development of trustworthy systems

All QorlQ SoCs support Trust Architecture





Generalized Comparison Between i.MX and Layerscape

Layerscape

- Scales to higher performance
- More PCI and Ethernet
- Industrial qualifications
- ECC on all memories
- Linux, OpenWRT

i.MX

- Scales to lower cost/power
- More graphics and multimedia
- Commercial, industrial, and auto qualifications
- Linux, Android



Nexcom NSA 3640 For Midrange Edge Systems



COMMITTED TO CUSTOMER SUCCESS





- Processing and memory
 - -NXP® OorIQ™ LS2088A, 8 Cores
 - Network accelerators
 - 5x DDR4-2400 DIMMs slots
 - Registered ECC-DIMM or U-DIMM
- Interfaces
 - -4x 10GbE copper ports
 - -4x SFP+ ports
 - 1x PCIe Gen3 x8 or 2x PCIe Gen3 x4 slots
 - -2x SATA 3.0



Delta Networks LS104x Design for Edge Systems

- Applications
 - Edge gateways
 - Security appliances
 - vCPE
- System
 - Desktop Fanless System
 - Layerscape LS1043A or LS1046A
 - On board 512MB DDR3L
 - On board 512MB SLC NAND Flash
 - 1x USB2.0, 1x USB3.0

- Networking Elements
 - 1x GE/SFP Combo port for WAN(optional)
 - 1x GbE port for WAN
 - 4x LAN GbE ports from 4p switch
 - 2 port PoE at/af(optional)





Start Developing TSN on LS1021A-TSN Enhance with LS1028A



LS1021A-TSN

TSN features

- Time aware shaper (802.1Qbv)
- Per-stream filtering & policing (802.1Qci)
- Credit-based shaper (802.1Qav)
- Time synchronization (802.1AS)

System features

- 4 switched Gigabit Ethernet TSN interfaces
- Arduino shield for IoT wireless integration
- Expandable IO mini PCIe, SATA, USB 3.0, SD Card, GPIO



LS1028A

New TSN features

- Frame Pre-emption (802.1Qbu)
- Frame Replication and Elimination (802.1CB)
- Cut-through Switching
- Cyclic Queuing and Forwarding (802.1Qch)
- 802.1AS-Rev
- New system features
- 4 CAN ports

Supported by one SDK – Open Industrial Linux



Intelligent Traffic Controller

- NXP is at the forefront of smart city/transportation development
- NXP has a V2X demo using multiple NXP products
- One Layerscape processor can fuse multiple inputs to control an intersection



NXP Edge-Box

NXP development kit for Edge Computing



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- NXP Edge-box
 - 64bit 1-4 ARMv8 cores up to 40K coremark.
 - 2-4 GE ports, 802.11ac/n Wifi, BLE.
 - USB, SD card, M.2, UART, GPIO, mini-PCIE for expansion/connectivity.
 - Pre-provisioned UID, secrets, OTA install/provisioning.
 - Multiple SKUs
 - Edge-box standard LS1043/6, 200-400\$
 - Edge-box lite LS1012, 50-100\$
 - Edge-box display LS1028, 100\$-200\$
 - Edge-box extreme LS2088, \$500

- Add-on peripherals
 - Vector-engine card/stick
 - Camera/audio

EdgeScale.org

Device and Application Management

Cloud Application Development

- Wifi/LTE/BLE/LowPAN modules
- Software ecosystem
 - Ready to run AWS GG, Azure, Aliyun, Google apps.
 - EdgeScale cloud-based device and application management.
 - EdgeScale cloud-base application development.
 - Choice of Ubuntu, Yocto or OpenWRT distros

Extreme Operating Conditions

10 Year Continuous operation at high temperature

- Product Life Application Notes
- Extreme temperature conditions
 - -40° C cold start
 - 70-85° C ambient operating conditions
 - Up to 125° C junction temperature
- Low power consumption for fanless designs
- Small footprint for space-constrained designs



Supply Longevity

Industrial applications require product longevity

- Long product lifecycles
- Special product certification required

NXP Industrial Application Processors

- 10 and 15 year supply longevity options
- Formal program with products listed at <u>www.nxp.com/productlongevity</u>







Key Take-Aways

NXP offers a broad portfolio of Layerscape processors

Layerscape integrates functions to **reduce system cost and power**

Layerscape delivers class-leading performance

NXP has reference designs and ODM partners to accelerate customers' TTM

Layerscape is robust and available for the long term





NXP Solution Expertise





Embedded Ecosystem is Evolving

Paradigm shift in embedded development

- Traditional: Vertical, platform-specific solutions
 - Take long time to market
 - Require large development teams
- Are not re-usable across platforms
- Emerging: Standard, Open ecosystem
 - Focus on applications
 - Leverage software re-use
 - Less time spent on hardware

Software is in the driver's seat

Applications are decoupling from hardware



NXP's Efforts to Bridge the Gap



Common Software Ecosystem Between x86 & ARM





NXP Linux Software





Different Ways to Get Linux





Platform Support Lifecycle

- Prior to upstreaming, NXP will provide standard SDK support.
- NXP is actively committed to upstreaming.
- Once upstreamed, NXP recommends to get support via community.
- Premium Support and Frozen Branch options a choice throughout via NXP Commercial Services









Components

- Freely available from public repositories, no need to download an ISO
- Modularized with discrete boot loaders, userspace libraries, tools, config
- Clean layering, with separate patches identified by platform/IP on top of open-source
- Git updates of periodic releases and interim updates
- Support for 2 recent LTS kernels

• Living with the SDK

- Multiple boot mechanisms with recovery via SD
- Run-time upgrades with apt-get or build from source
- Latest and greatest Layerscape tools and drivers
- LSDK is not a Linux distribution but a reference integration with a Ubuntu user land





Edge Computing Ecosystem







The Grappe Areas



Smart Nodes NXP i.MX (Machine-learning) Smart-nodes can run targeted Edge applications





Customer Solution AWS Azure Aliyun App App App NXP NXP SW Platform **Application Framework** Linux Platform Secure Firmware **Edge Gateway** NXP Layerscape

(Control, Analytics, Machine-Learning)

Gateways are a natural host for edge computing – right balance of compute, connectivity and storage Edge computing is the application of cloud technology outside a large data center.

<u>Network</u>	Cloud
	阿里云计算 Alibaba Cloud Computing
	Google Cloud Platform
	Microsoft Azure
	webservices
Network Infrastructure	
NXP Layerscape	
(Aggregation, Analytics)	
Edge applications can also	
run on access – e.g., base	

stations, central office -

costlier pipe, higher latency.



Security Is Multifaceted



PRIVACY

preventing **eavesdropping**, data exfiltration **EXAMPLE** Encryption

AUTHENTICATION

guaranteeing identity EXAMPLES

User IDs (e.g., passwords) Hardware IDs

ACCESS CONTROL

limiting **use** and **communication EXAMPLE** Access control lists

SYSTEM INTEGRITY AND AVAILABILITY

ensuring data and code **accuracy** preventing service **theft** and **denial**, **cloning**

EXAMPLES Secure boot Runtime integrity checking



Examples of IoT Hacks



Automobile

- Telematics hacked to:
 - Eavesdrop
 - Control ECU



Point of Sale

- Memory scraper
 installed on POS
- POS exfiltrates credit card info



Home Routers

- Root access and program installation
- DDOS launched

Vulnerabilities Exploited Flawed Authentication Stack Overflow No End-to-End Security No Memory Protection





Management and Security Challenges



Solution: Cloud-based Management & security for edge

- Manage devices, apps remotely
- Secure provisioning, upgrades

Traditional PC, mobile devices

- Multiple authentication mechanisms
- Cloud based security and application management

Edge computing devices

- Traditionally embedded devices
- Not physically accessible, or lack display
- Can be many (10s, 100s, 1000s) per user



Security Requirements for the Edge

Secure

Enrollment

Chain of Trust

01

- Security starts with hardware root of trust
- End-to-end security is a chain of inter-locked security elements

Secure

Manufacturing

Credentials may be installed in onchip Layerscape fused memory or via external Secure Element.

Secure

Device

Monitoring

Secure Application Deployment

U5

Secure

Container

Deployment

Device Management

- Secure manufacturing
- Secure enrollment
- Secure device monitoring and firmware management
- Secure container deployment
- Secure app management and deployment



EdgeScale for Device Management



EdgeScale – Flexible Architecture





EdgeScale Architecture



Open-Source

NXP Provides

COMPANY PUBLIC 45

Cloud Apps

Embedded Apps



How NXP Makes Edge-Framework Security Simpler



EdgeScale solution:

- Automates edge framework software and key distribution
- Deploys framework core as signed Docker image
- Provides on-device trust computing and secure storage for apps







NXP Works With Cloud Companies' Edge Frameworks

Amazon Web Services (AWS)

- Greengrass integrated with Layerscape
- Edge demos using Greengrass and AWS
- EdgeScale integrated with AWS and GG
- http://media.nxp.com/phoenix.zhtml?c=254228&p=irolnewsArticle&ID=2289486

Microsoft Azure IoT Edge

- Azure IoT Edge supported on Layerscape
- Focus on secure execution and Docker
- <u>http://media.nxp.com/phoenix.zhtml?c=254228&p=irol-newsArticle&ID=2334845</u>

• Alibaba Cloud (Aliyun)

- NXP processors uniquely support Alibaba TEE OS
- Alibaba and NXP plan to jointly develop smart manufacturing and smart city applications
- <u>http://media.nxp.com/phoenix.zhtml?c=254228&p=RssLanding&cat</u>
 <u>=news&id=2322324</u>



Key Take-Aways

NXP understands and addresses key trends Embedded systems IoT and edge computing

NXP understands and addresses security and device-management challenges

NXP Trust Architecture

EdgeScale

NXP leads in collaborating with cloud companies on edge frameworks

Accelerates NXP customers' time to market

Improves security









Building Automation

- Killer app is linking systems via an edge-computing nexus
- HVAC + surveillance
 - -Start HVAC when employee arrives
- HVAC + weekly weather forecast
 - -Plan vs react
- Ingress + egress security cameras
 - Did someone leave behind a backpack?
- Sensors + fire alarm
 - -Warn if unusual electric load, items piled up near boilers, etc.



Home Automation



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- Fire/burglary alarm
- Remote unlock
- Security cameras
- Remote doorbell
- Thermostats
- Smart speakers
- How edge computing differs
 - -Learning done locally
 - -Local intersystem coordination
 - Shared learning (e.g., voice, face recog)
 - Automation enabled when house offline
 - -Privacy





Warehouse Automation

Robots shuttle shelves

Conveyer belts transport goods

Machines dispense tape and boxes

Edge computing orchestrates everything





Medical and Healthcare Monitoring and Automation

- Surgery robots
 - Parallels factory automation development
 - Edge nodes monitor and analyze sensors
 - Edge nodes coordinate robots
- Patient monitoring
 - Edge computing enables offline analysis
 - Edge computing enables sensor fusion





NXP is Bringing EdgeScale to an Alligator Farm

- Alligator farm has pole- or towermounted observation hardware
- Today: firmware updates requires dangling from a helicopter with a PC and cable
- Same constraints apply to industries with remote equipment like oil/gas
- EdgeScale remote management enables low-cost remote updates



NXP Has Shown Enterprise and Retail Video Analytics

- Customer check-in
 - -Face and ID correlation using AI
- Retail analytics using AI
 - -Hot spot detection
 - -Face recognition
 - -Correlate items browsed with shoppers
 - -Shoplifting detection



Source: NXP



NXP MCUs Can Instrument Factory Equipment



- Predictive maintenance
- Condition monitoring for anomalies
 Vibration, temp, sound, etc.
- Chaotic outer control loops
 - Neural nets to predict chaotic systems
- AI-based visual inspection
- Machine control using sensor data
- Edge computing advantages
 - Distributed preprocessing
 - Reduce data, spread computational load
 - Low latency



NXP Is Already Engaged in V2X Development

- Aggregate data
 - -Sent by cars
 - Observed by fixed cameras
 - Observed via radar
 - -Sent by other V2X nodes
- Analyze and control objects
 - -Track objects
 - Predict objects' behavior
 - Control behavior with signaling
 - Manage pedestrian and vehicle queues
- Identify carpool and other violations





How Can Edge Computing Be Used in Aircraft?

Real-time analysis of engines and other flight data?

- Preventative maintenance
- Fuel-economy optimization

In-cabin entertainment and services?

- Management of seatback systems
- Security/isolation of systems
- Health and safety



Key Take-Aways

Edge computing is **broadly applicable**

Al is a killer app for edge computing

NXP is actively developing edge applications for demonstration and with customers







How Might Edge Computing Transform the World?

- Bigger role for software in traditionally hard industrial systems
 - Affects what industrial companies offer (e.g., GE Predix)
- Software development becomes more IT-like
 - -Abstract
 - -Leveraging frameworks, containers/VMs
 - Decouple from hardware
 - Easier to manage
- Bigger role for cloud service providers
- Improved cost, performance, and safety by fusing multiple systems' inputs

How Might Al Transform the World?

Machine-generated models factor in more data than man-made ones

Better models yield better analytics, revealing hitherto hidden insights

New, gee-whiz features (e.g., remote unlocking of your house)

Reduced cost (e.g., predictive maintenance)

Improved safety (e.g., stopping worker without hardhat from entering)

Bigger role for software in traditionally hard industrial systems – Continues the trend that started with replacing analog with digital control



How Might Processors Change?

- Cross-vendor compatibility is increasing owing to:
 - -Arm
 - -Containers/VMs
 - -Frameworks
- Accelerators will become transparent to software
- AI accelerators will become common even in small-scale processors





Summary: NXP Layerscape Offerings Layerscape: a broad portfolio of Armcompatible processors integrating I/O

Linux and enabling software

ODM and reference designs

EdgeScale for edge/IoT node management

Cloud framework support

Demos and early-stage success in edge computing



Transform Your Business with Edge Computing and Al Using Layerscape!





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