Winning with i.MX 8 and i.MX 8X Applications Processors

Pat Stilwell

i.MX Product Marketing

June 2019 | AMF-AUT-T3506

SECURE CONNECTIONS FOR A SMARTER WORLD

CONFIDENTIAL & PROPRIETARY – NXP, the NXP logo, and NXP secure connections for a smarter world are trademarks of NXP B.V. All other product or service names are the property of their respective owners. © 2018 NXP B.V.

Agenda

- Why i.MX?
  - Trust. Scalability. Support.
- i.MX 8/8X Overview
- i.MX 8 Series Support
  - Operating Systems, Partners

i.MX 8X Docs

- **For the latest i.MX 8X documentation, BSPs, and files, visit:**

- **Product Page: www.nxp.com/imx8x**
  - Datasheets
  - Reference Manual
  - Product Fact Sheet

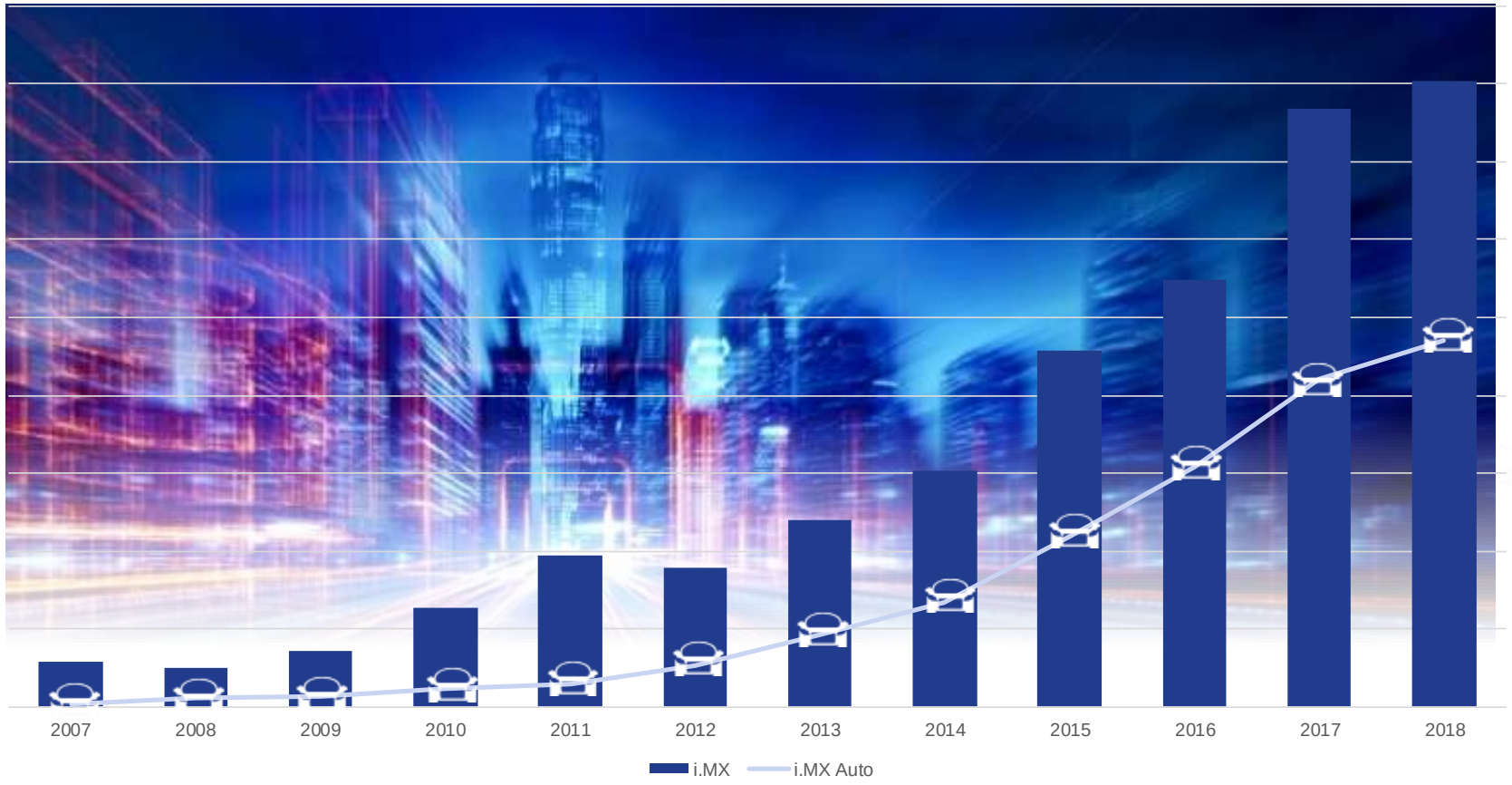
- **Multisensory Enablement Kit (Evaluation Board) Page: https://www.nxp.com/mcimx8qxp-cpu**
- Includes the following:
  - Getting Started Instructions
  - Design Files
  - Links to BSPs
  - Multisensory Enablement Kit Fact Sheet (Eval board)

- **i.MX 8QuadXPlus MEK board accessories page: http://nxp.com/i.MX8-ACCESSORY-BOARDS**

- Other links:

  - MCUXpresso - https://mcuxpresso.nxp.com
  - Pins Tool - https://www.nxp.com/pages/pins-tool-for-i.mx-application-processors:PINS-TOOL-IMX?tab=Design_Tools_Tab

i.MX Explosive Growth to Date



Over **600M i.MX shipped**.

Over **200M i.MX shipped in vehicles** since 2007.

#1 in Auto Infotainment Applications Processors

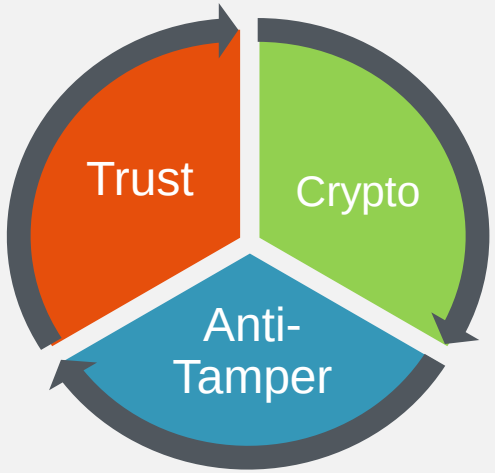
#1 in Reconfigurable Clusters

Growth with scalable ruggedized solutions, well-trusted for HMI, machine learning, and industrial control solutions.

Additional Auto usage in Telematics, V2X, Smart Antenna, Driver Monitoring, Surround View, HMI, Gateway, ADAS

Scalability, Trusted Supply & Support

Product Longevity



i.MX Applications Processor Values

- Trusted Supply
  - Product longevity: Minimum 10 to 15 years
  - Security and safety: Hardware acceleration, software
  - Reliability: Zero-defect methodology, ULA, low SER FIT
  - Quality: Automotive AEC-Q100, Industrial/Consumer JEDEC
- Scalability for Maximum Platform Reuse
  - Pin compatibility and software portability
  - Integration: CPU (single/dual/quad, asymmetric), GPU, IO
  - Software: Linux, Android, FreeRTOS
- Support and Enablement
  - Industry-leading partners and support community
  - Manufacturability: 0.65 to 0.8mm options, fewer PCB layers
  - System solutions: SoC, sensors, memory, PMIC, connectivity, standard products, software

Why i.MX?

Trust. Scalability. Support

NXP Product Longevity Program

NXP formally offers many devices for a minimum of 10 or 15 years from the time of launch

- Participating NXP products and program terms are listed at www.nxp.com/productlongevity
- i.MX 8 series plans to launch with 10 and 15 year longevity options

Extreme Operating Conditions

- **10+ year product operating life** with continuous operation
- Product Life Application Notes
- Extreme **temperature conditions**
  - -40^{o} C cold start
  - 70-85^{o} C ambient operating conditions
  - Up to 125^{o} C junction temperature
- Low power consumption for **fanless designs**

Qualification Specifications for i.MX Applications Processors

Qualification Level	Characteristics
Commercial or Consumer Highest MHz	5-year life, 50% on Typically: 0C to +85C Tj
Automotive Widest temperature range	15-year life, 10% on Typically: -40C to +125C Tj
Industrial Longest operating life	10-year life, 100% always on Typically: -40C to +105C Tj

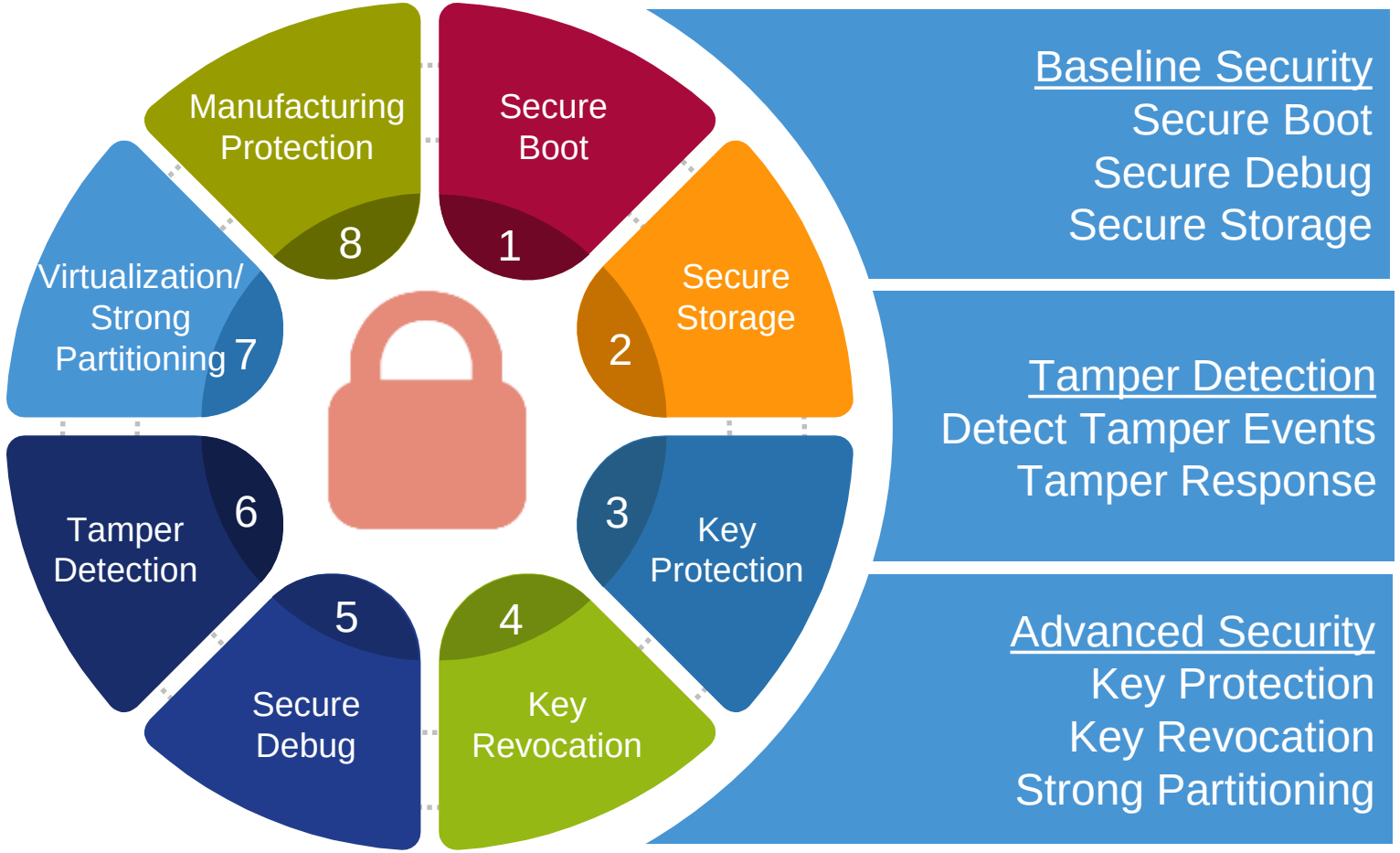
NXP Leverages Core Competence in End-to-End System Security

Mobile and stationary machines want full access to cloud-based knowledge

This requires **faster, more reliable** and secure connectivity

NXP is at the **forefront of secure communications** and tamper resistance

Leadership experience in security markets: over 10 Billion smart cards sold



i.MX MARKET LEADING ECOSYSTEM AND SUPPORT

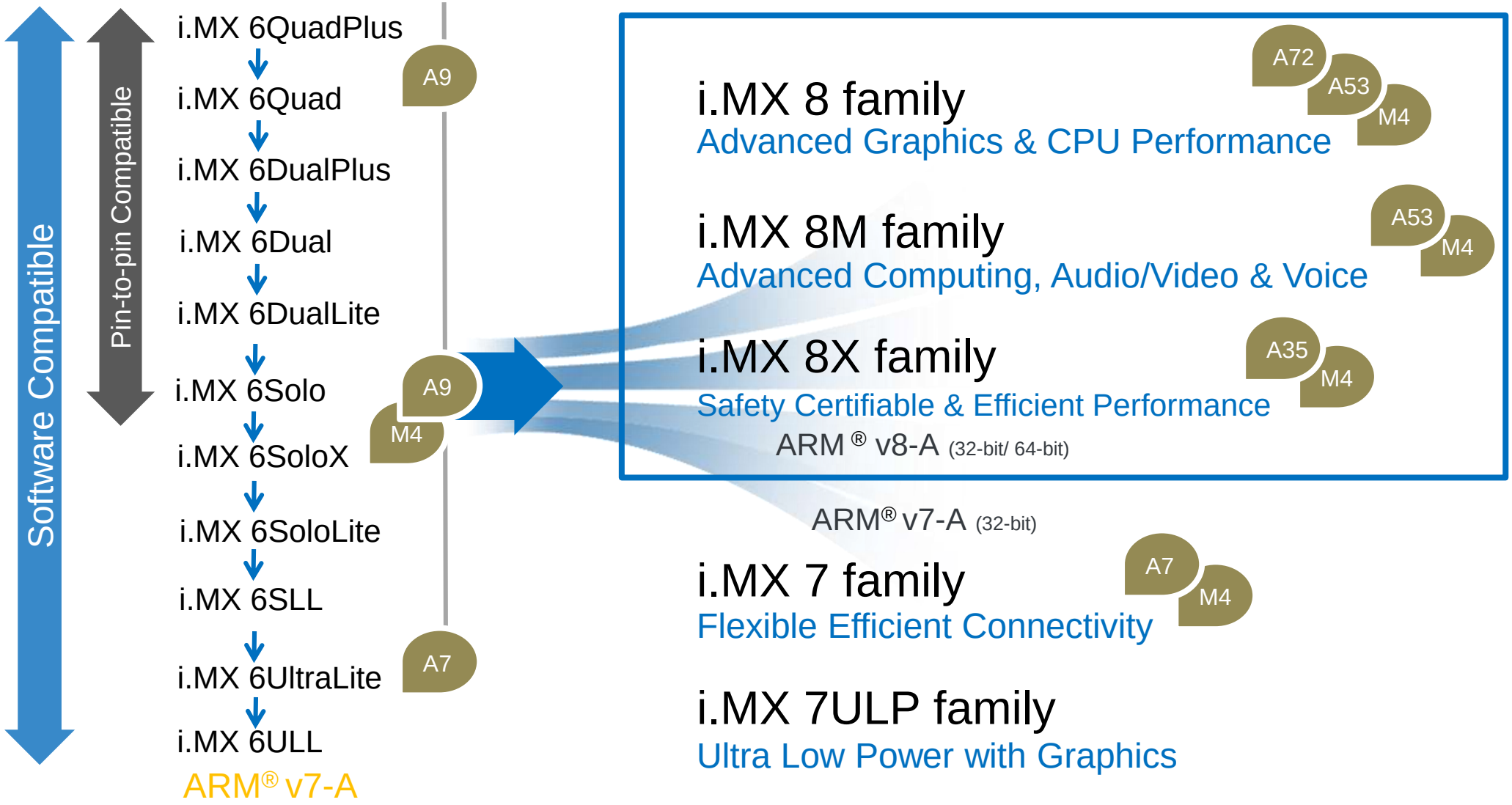
Built to support **thousands of customers** with **world-class** enablement, ecosystem, community, services and field resources

i.MX 8 Series Overview

i.MX 8 and 8X Families

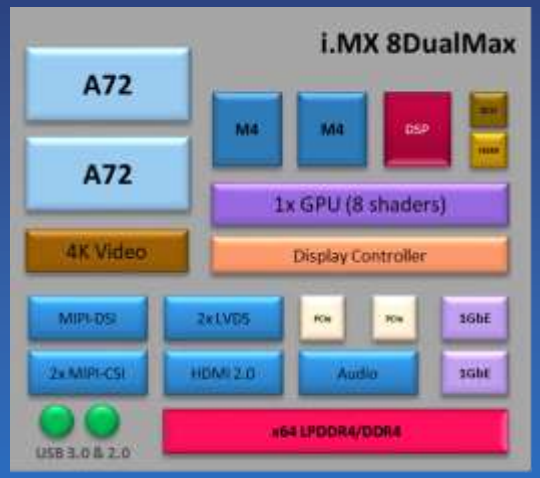
www.nxp.com/imx8

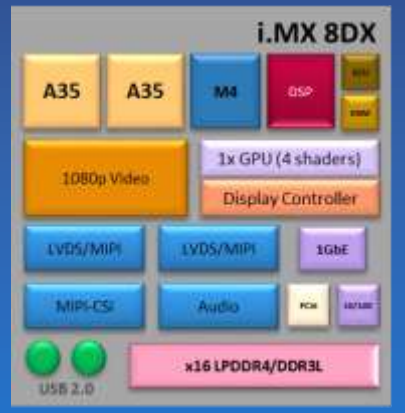
i.MX Applications Processor Scalability



i.MX 8, 8X and 8X Lite Subsystem Reuse

Scalability of Embedded Processing





Future

HMI, Vision, Audio and Voice-enabled with i.MX

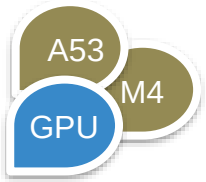
DSP, Vision Acceleration, Real Time Domain, Safe Camera/Display/Audio, Simplified eCockpit

New TSN Connectivity, Telematics and V2X Optimization with i.MX 8DualXLite / 8SoloXLite

i.MX 8 Series: Target Applications

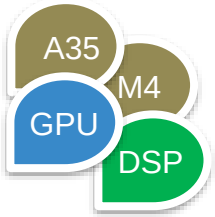
Advanced graphics, video, image processing, vision, audio and voice

i.MX 8M Family



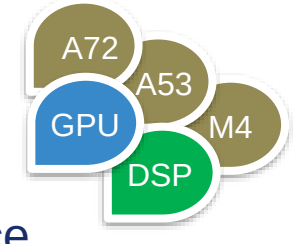
Advanced Computing,
Audio/Video & Voice

i.MX 8X Family



Safety Certifiable &
Efficient Performance

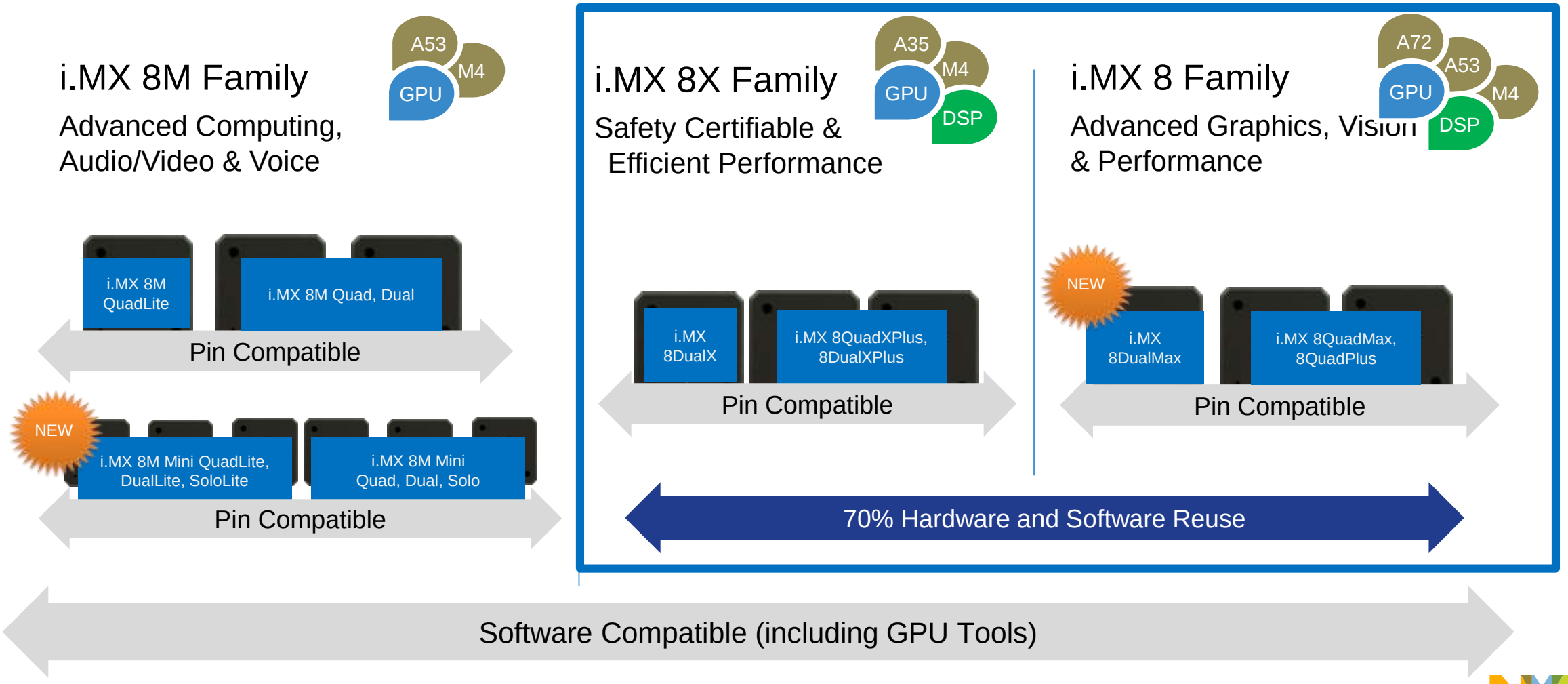
i.MX 8 Family



Advanced Graphics,
Vision & Performance

i.MX 8 Series: Scalable Solutions

Scalable series of three Arm V8 64-bit (/32-bit) based SoC Families

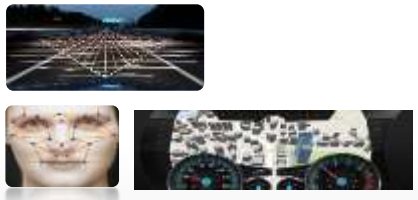


i.MX 8/8X Safety and Reliability Features

Safety Feature	8QuadXplus, 8DualXPlus, 8DualX	8QuadMax, 8QuadPlus
Ultra Low Alpha (ULA) package	✓	✓
Manufacturing Process	28nm FD-SOI	28nm FD-SOI
Memory Protection (ECC, parity)		
ARM Cortex-A L1 cache	Parity	Parity
ARM Cortex-A L2 cache	ECC	ECC
ARM Cortex-M4 tightly coupled memory	ECC	ECC
DDR memory interface	ECC on DDR3L	-
Failover Displays and Cameras	✓	✓
Highest Automotive Safety Certifiable	ASIL-B	ASIL-B
Highest Industrial Safety Certifiable	SIL 3	SIL2

i.MX 8 and 8X Families

32 - 64 bit OS compatibility from entry to premium segments



i.MX 8

Advanced Graphics & Performance

ARM® v8-A Cortex-A53 / A72

Scalable family of products for advanced multi-display HMI, eCockpit and vision-enabled systems with security and low virtualization software overhead

i.MX 8X

Safety Certifiable & Efficient Performance

ARM® v8-A Cortex-A35

Scalable family of products for display audio-enabled HMI, infotainment, reconfigurable instrument clusters and telematics / V2X applications.

Safe

SAFE ASSURE

Advanced support for ASIL-B Display and Camera Applications

Scalable

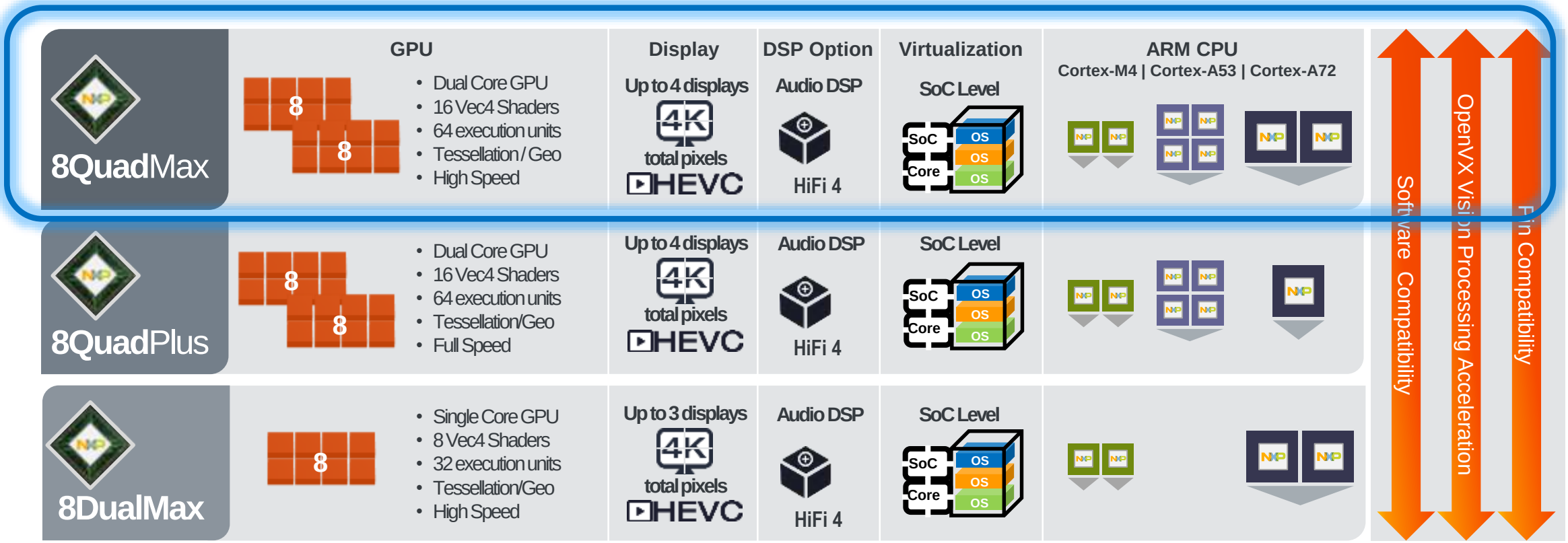
Common architecture with ~70% design reuse

ARM v8-A Compatibility to support common applications

Secure

Common security subsystem with advanced crypto and HSM support

i.MX 8 Family of Applications Processors



Family of Scalable Multimedia Processors

Multiple Operating Systems

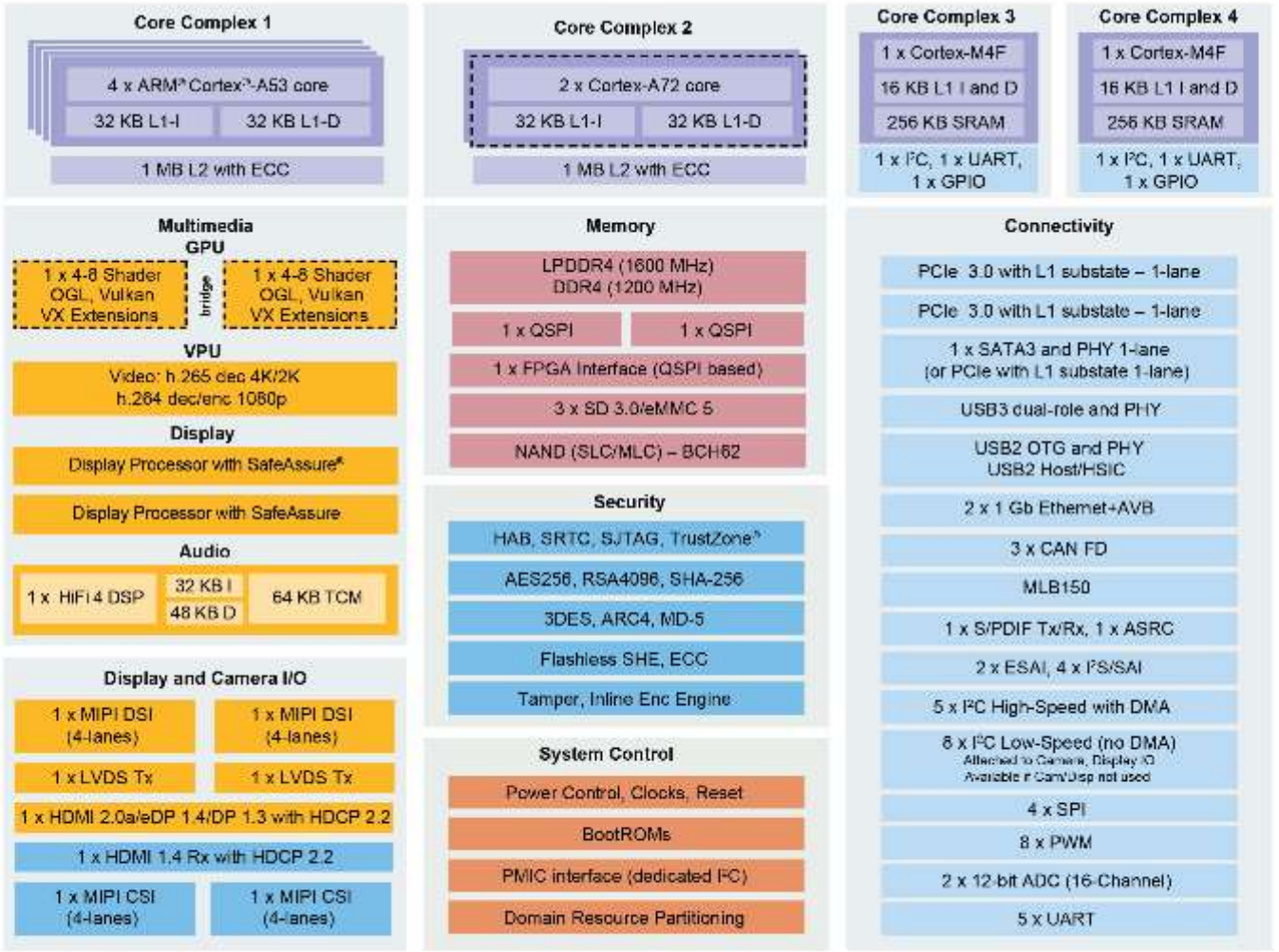
Multiple Domains with Hardware Virtualization

Multiple Displays

Vision Processing Hardware Acceleration

i.MX 8 Family of Applications Processors

New



Feature	i.MX 8QuadMax	i.MX 8QuadPlus	i.MX 8DualMax
ARM® Core	2 x ARM Cortex®-A72	1 x Cortex-A72	2 x Cortex-A72
ARM® Core	4 x Cortex-A53	4 x Cortex-A53	-
ARM® Core	2 x Cortex-M4F	2 x Cortex-M4F	2 x Cortex-M4F
DSP Core	Tensilica® HiFi 4 DSP	Tensilica HiFi 4 DSP	Tensilica HiFi 4 DSP
GPU	2 x GC7000XSVX	2 x GC7000Lite/XSVX	1 x GC7000XSVX
PCIe	1 x PCIe (2-lane)* + 1 x PCIe (1-lane)	1 x PCIe (1-lane)	1 x PCIe (1-lane)

*2-lane PCIe can act as 2 x 1-lane PCIe

Packages:
- 29x29 0.75 FC-PBGA
- 23x23 0.75 FC-PBGA

Available on certain product families Note: Accessing muxable controller's full capabilities is dependent upon board component choices.

i.MX 8X Family of Applications Processors

	GPU		Video	Displays	DSP	USB	DDR	ARM CPU Cortex-A35 + M4
8QuadXPlus	4	• Single Core GPU • 4 Vec4 Shaders **high performance** • 16 execution units • OpenGL ES 3.1 • OpenCL Embedded	4K HEVC H.264 MPEG-4/AVC + Legacy	Up to 3 2x 1080p 1x WVGA	HiFi 4	HI-SPEED USB SUPERSPEED USB	x32 DDR3L-1866 (ECC option) LP-DDR4-2400 (no ECC)	
8DualXPlus	4	• Single Core GPU • 4 Vec4 Shaders **high performance** • 16 execution units • OpenGL ES 3.1 • OpenCL Embedded	4K HEVC H.264 MPEG-4/AVC + Legacy	Up to 3 2x 1080p 1x WVGA	HiFi 4	HI-SPEED USB SUPERSPEED USB	x32 DDR3L-1866 (ECC option) LP-DDR4-2400 (no ECC)	
8DualX	4	• Single Core GPU • 4 Vec4 Shaders **power optimized** • 16 execution units • OpenGL ES 3.1 • OpenCL Embedded	H.264 MPEG-4/AVC + Legacy	Up to 2 *1x 1080p +1x WVGA	HiFi 4	HI-SPEED USB	x16 DDR3L-1866 (no ECC) LP-DDR4-2400 (no ECC)	

Software Compatibility

Pin Compatibility

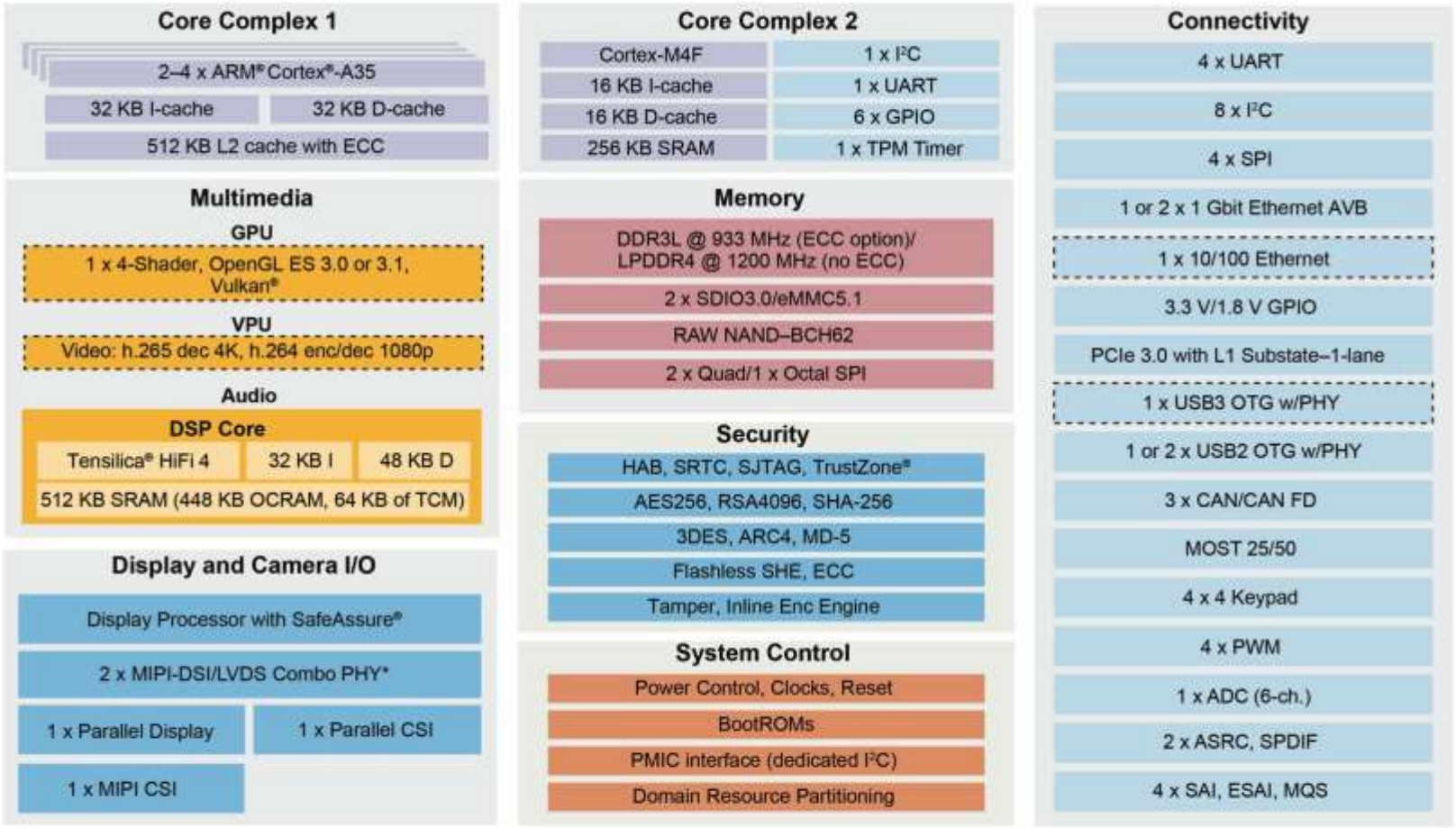
* Bandwidth limited

Family of Scalable Multimedia Processors

Industrial Grade Qualification with Error Correcting Code (ECC) on DDR3L interface

Automotive Qualification for high temp, duty cycled applications

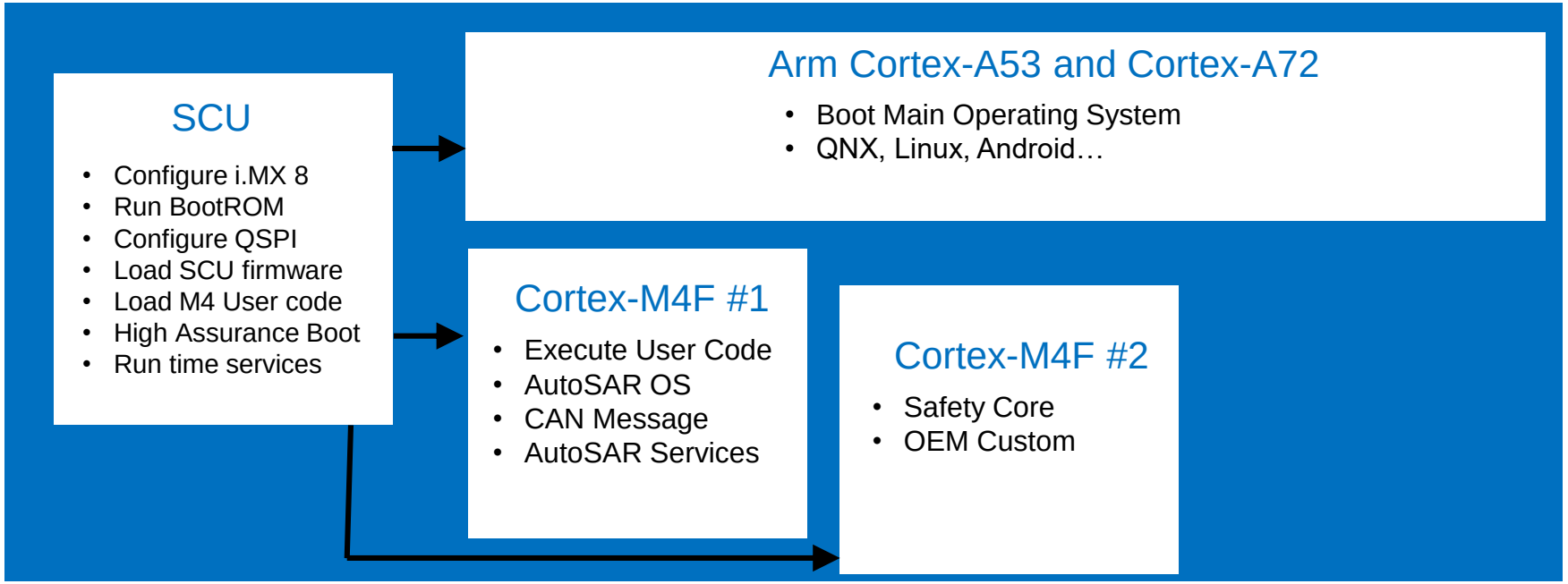
i.MX 8X Family of Applications Processors



Feature	i.MX 8DualXPlus / i.MX 8QuadXPlus	i.MX 8DualX
ARM® Core	2 x Cortex-A35 (i.MX 8DualXPlus) 4 x Cortex-A35 (i.MX 8QuadXPlus)	2 x Cortex-A35
ARM® Core	1 x Cortex-M4F	1 x Cortex-M4F
DSP Core	Tensilica® HiFi 4 DSP	Tensilica HiFi 4 DSP
DRAM	32-bit DDR3L (ECC option)/ LPDDR4 (no ECC)	16-bit DDR3L (no ECC) / LPDDR4 (no ECC)
GPU	1 x GC7000Lite (4-shader)	1 x GC7000Lite (4-shader) power optimized
VPU	4K h.265 dec 1080p h.264 enc/dec	1080p h.264 enc/dec
Ethernet	2 x Gigabit with AVB	1 x Gigabit with AVB 1 x 10/100
USB with PHY	1 x USB 3.0 (or USB 2.0) 1 x USB 2.0	2 x USB 2.0

Available on certain product families Note: Accessing muxable controller's full capabilities is dependent upon board component choices.

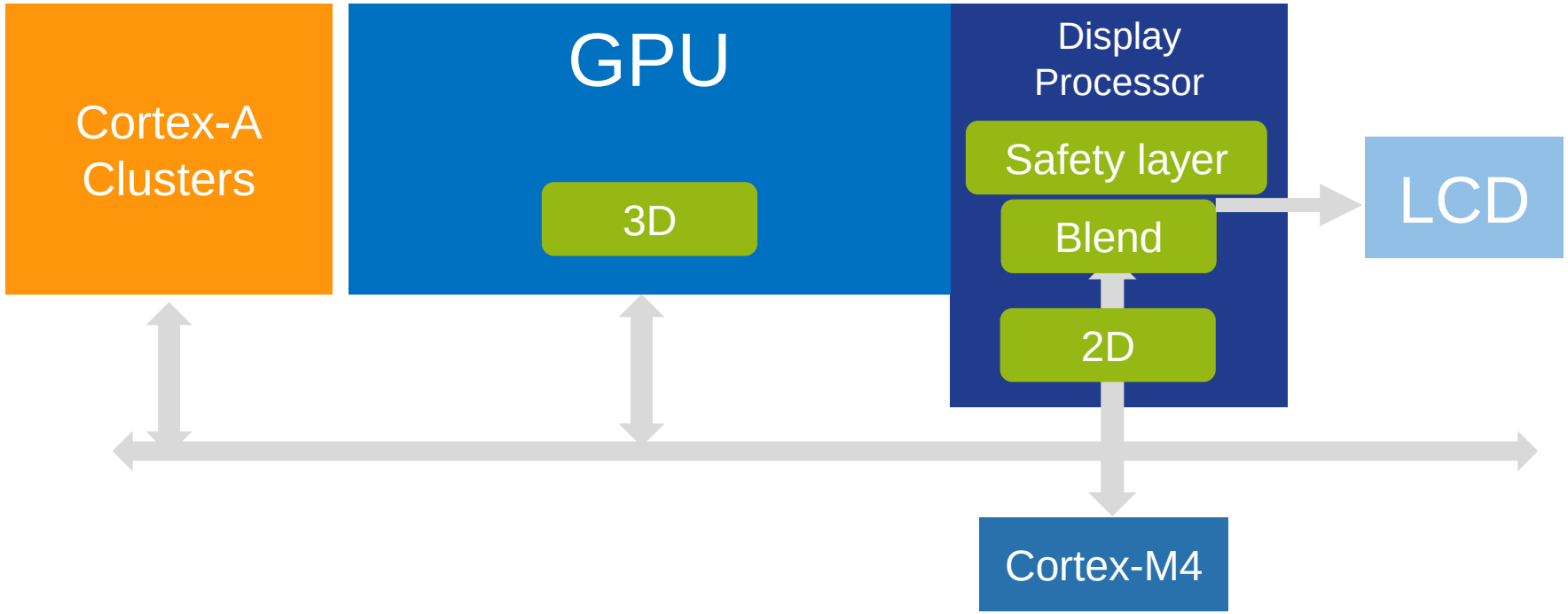
i.MX 8 and 8X Flexible and Fast Boot



i.MX 8 and 8X Boot Flow

- Flexible multi-boot options
- Critical function alignment (Cortex-M4 versus Cortex-A53)
- Enables early backup camera, CAN receipt and display

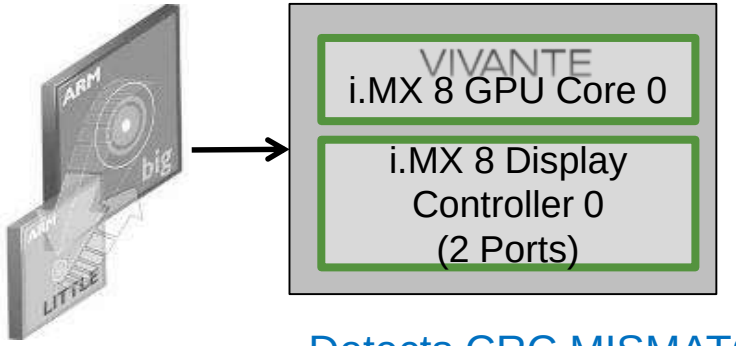
i.MX 8 and 8X Family Display Processor with Failover Feature



i.MX 8 and 8X Family Display Processor:

- Runs independently, even if GPU and Cortex-A cores crash
- Has integrated 2D graphics unit
- Can be driven by Cortex-M4 core (safety layer support)
- Can drive 4x independent displays without the GPU

i.MX 8 Display Failover Strategy



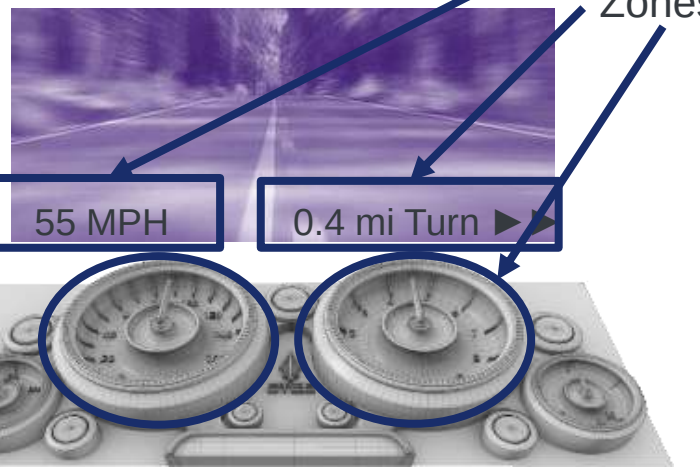
VIVANTE
i.MX 8 GPU Core 0

i.MX 8 Display Controller 0 (2 Ports)

Detects CRC MISMATCH

CRC Checking Zones

HUD

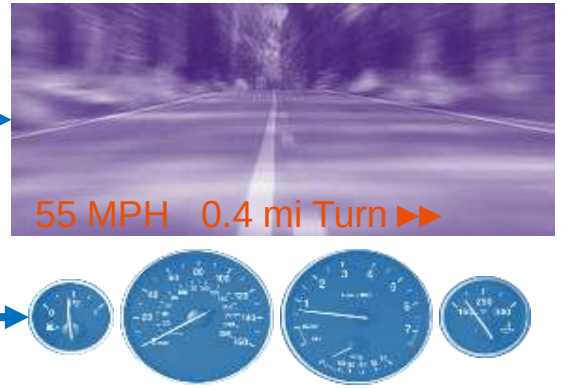


Cluster

Failover images running in background

~~VIVANTE i.MX 8 GPU Core 0~~

i.MX 8 Display Controller 0
Safety Streams x 2



Automatically Switchover to Simplified Cluster / HUD

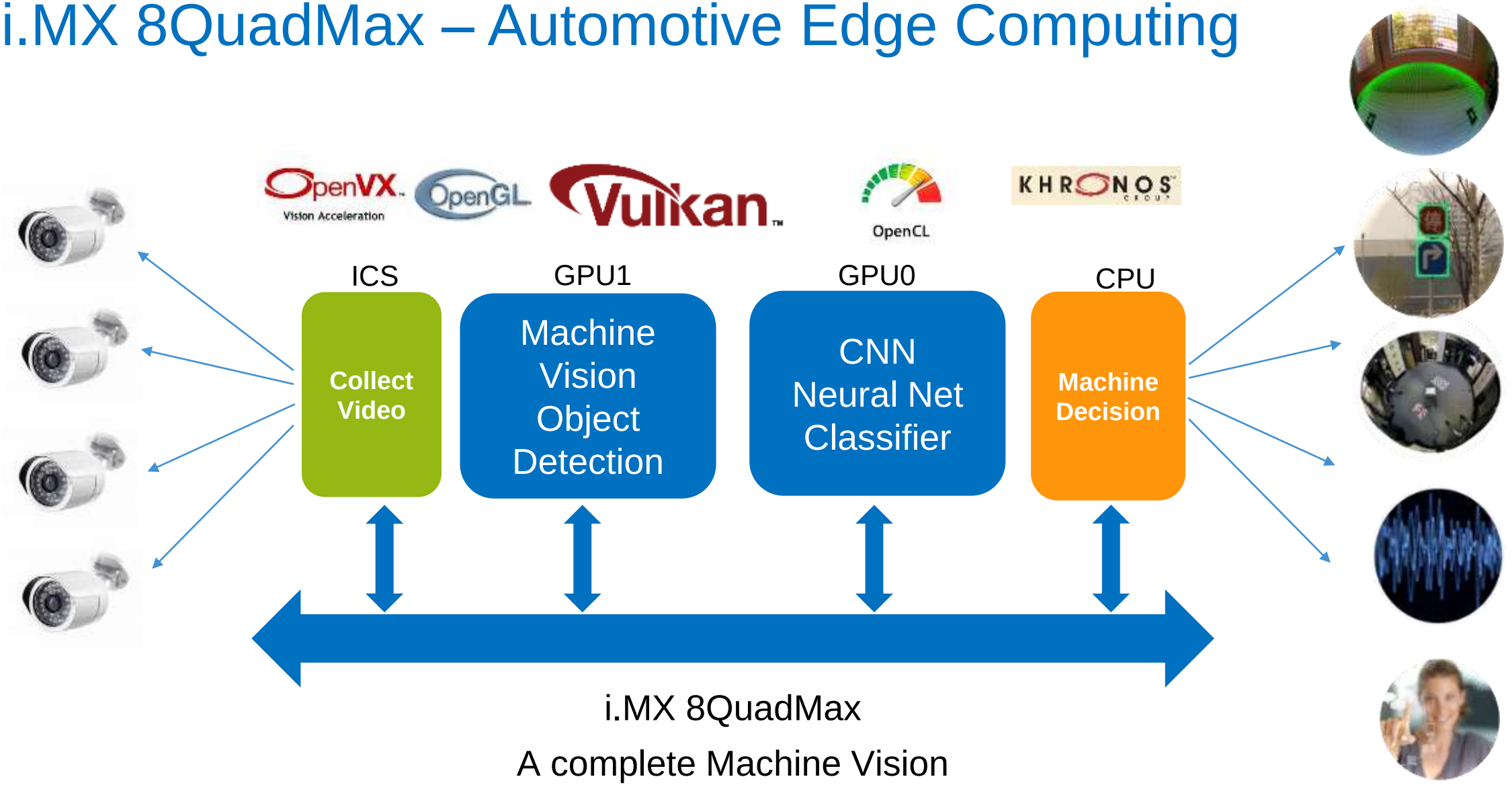
Second Order Benefit: Animation at Power On

- Display animated Company logo
  at power up, prior to boot
- Gracefully handle a system firmware upgrade with notifications
- Drive secondary display that cannot be ‘corrupted’ by main display

‘Failover’ Display

Normal Display

i.MX 8QuadMax – Automotive Edge Computing



i.MX 8QuadMax

A complete Machine Vision
and Neural Net Processing Edge Node

I Want to Run Two Operating Systems. Competition's Limitations?

What I want to do:
2x independent platforms, same chip

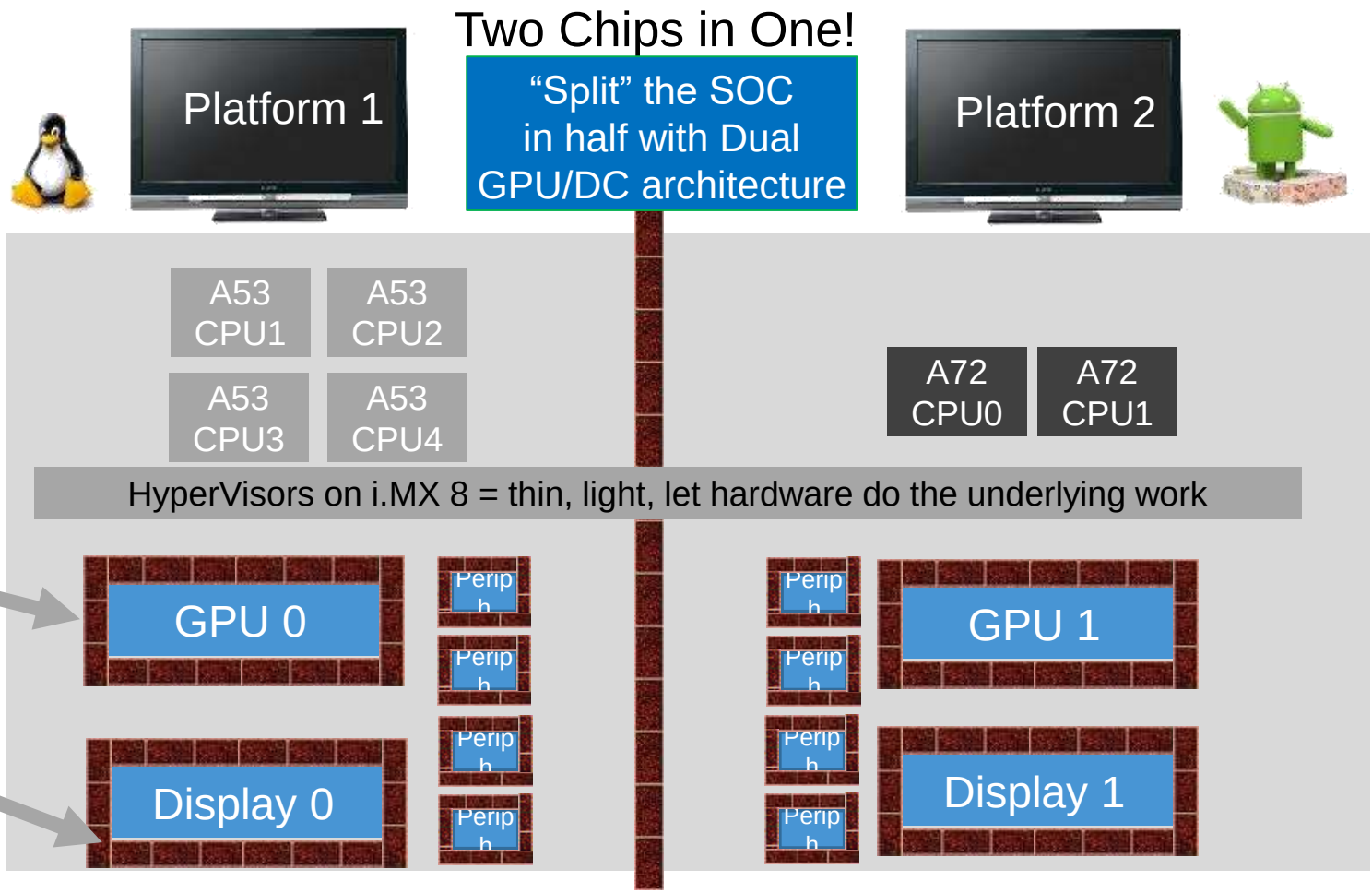
Someone Else's Processor

Steers requests, ensures no access conflicts, protects domain secrets

'Shares' all IP resources with only SW to guarantee protection

What I want to do:
2x independent platforms, same chip

i.MX 8Quadmax/QuadPlus Family: Full Chip Hardware Virtualization with Resource Domain Protection



Each IP Block has Hardware-based resource protection 'stitched' around it

Block, allow, assign, alert and track any transaction in Hardware!

Explicitly assign peripherals to a Platform

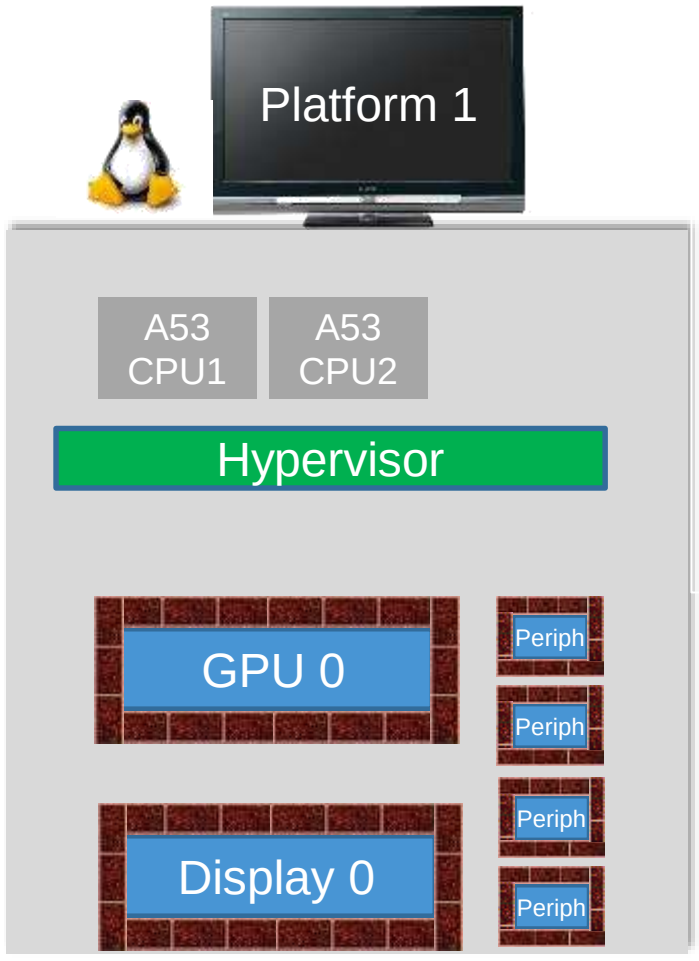
Second Order Benefit

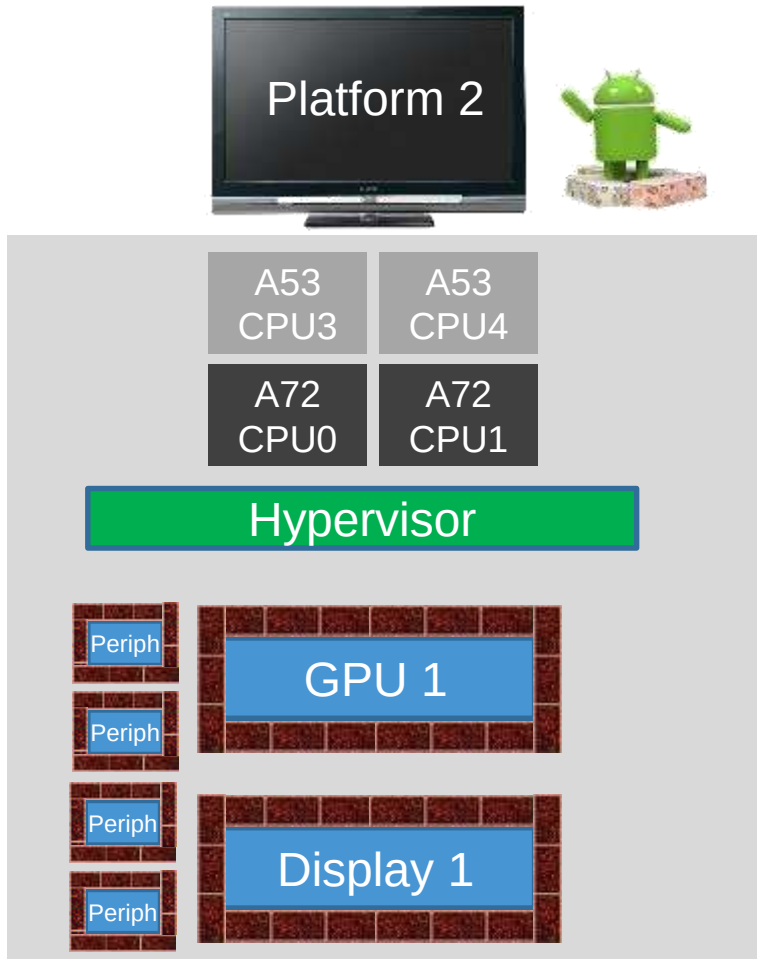
Develop the Linux ‘side’
independently and in isolation from
fully developing the Android ‘side’

Then ‘merge’ them together
at the last minute

They don’t share resources so...

Two Chips in one, remember?





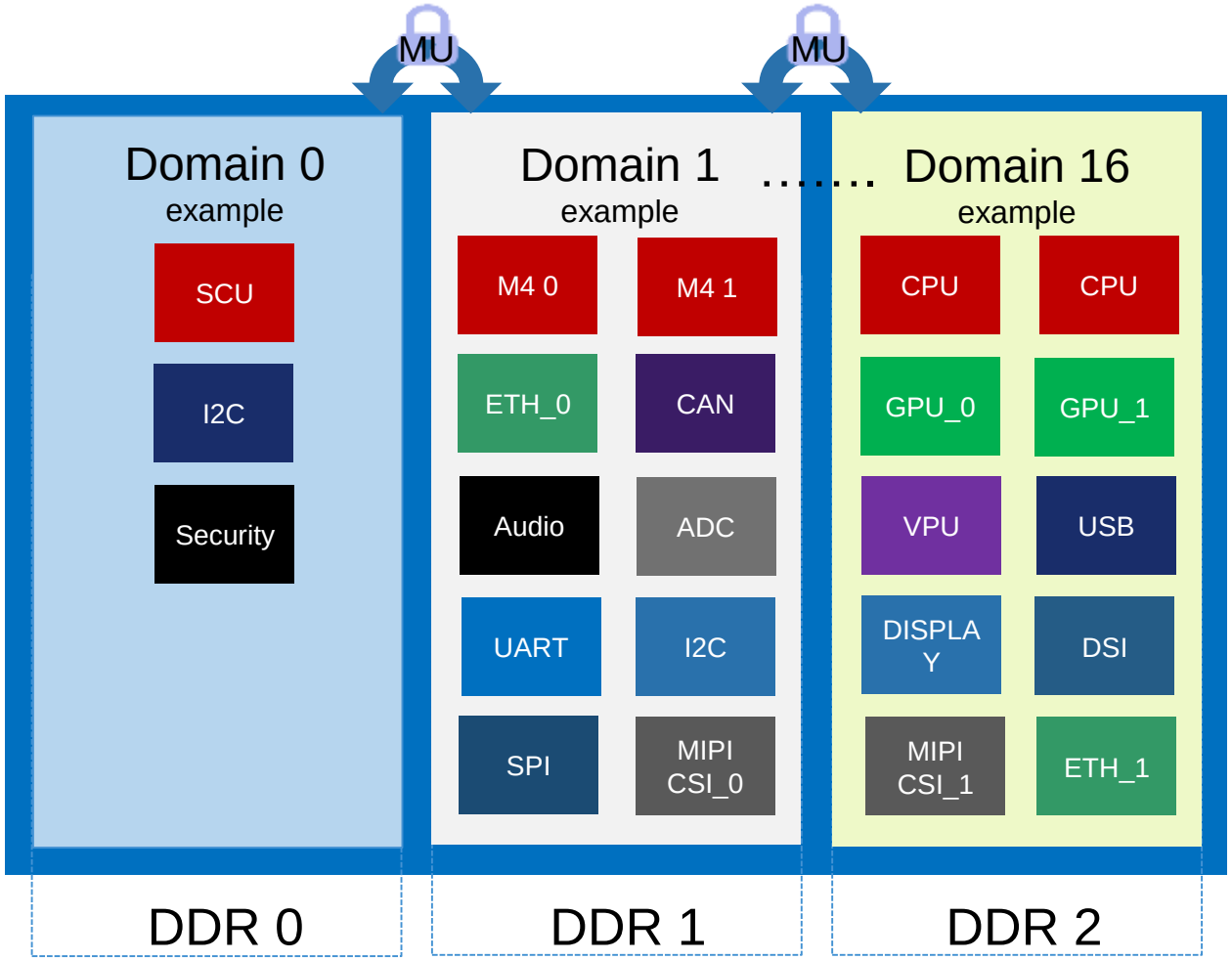
Resource Partitioning on i.MX 8 Family

How Partitioning Works:

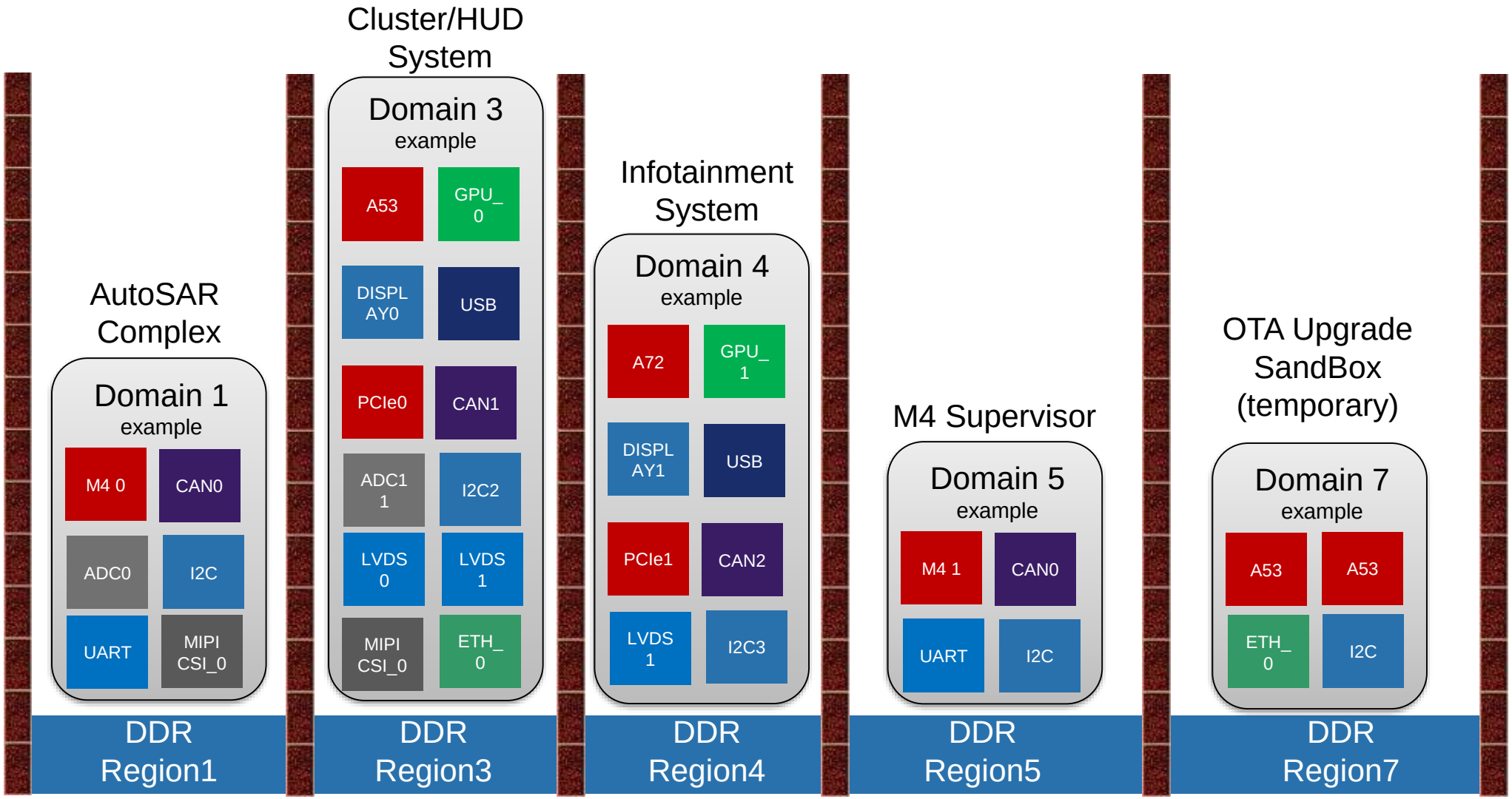
- The system controller commits peripherals and memory regions into a specific domains. (This is customer defined in the System Configuration Data)
- Any communication between domains are forced to use messaging protocols through Messaging Units (MU's)
- If a domain peripheral tries to access other domains illegally, a bus error will occur.

Benefits of Partitioning:

- Reporting of immediate illegal accesses helps track down hard to find race conditions before they go to production (AKA Sandbox Methods)
- Provides security on a finished product: protects system critical SoC peripherals from less trusted apps and intentional security breaches

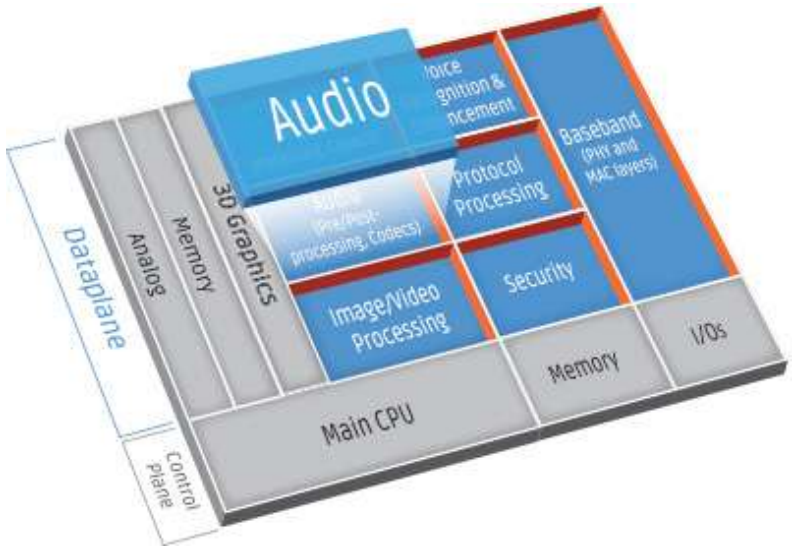


Domaining Partitions @ Runtime



Tensilica HiFi 4 High Performance Audio DSP Core

- Offload the ARM core: Highly optimized audio processor geared for efficient execution of audio and voice codecs and pre- and post-processing module
- Expansive Range of Audio Software
- The HiFi 4 Audio Engine is a configuration option that can be included with the Xtensa LX 6 processor
- Ease of Programming: All HiFi 4 Audio Engine operations can be used as intrinsic in standard C/C++ applications. Simplifies maintenance of existing codecs and development of new codecs.
- Toolchain is flexible to build what you want



Power Management IC – PF8100/8200

- Proven robustness, lower risk, & shorter time to market
  - Co-developed with MCU team
  - Support of advanced MCU technologies with high precision and enhanced thermal management
- Reduced complexity for functional safety implementation
  - Scalable Functional safety from QM to ASIL-B
  - Inputs to monitor additional supplies enables system level functional safety
- Reduced system cost
  - Scalable Architectures matched to MCU and application
  - OTP configurability allows flexibility during development
  - Optimize BOM size (<200mm2 component area)
- Faster certification through radiation reduction
  - Multiple frequency tuning optimization (Spread Spectrum, freq sync, Manual tuning)

PF8100/8200 Power Management IC Part Numbers for i.MX 8X

Part	Target	Automotive Part Number	Industrial Part Number
PF8100	i.MX 8X with LPDDR4	MC33PF8100CCES	MC34PF8100CCEP
PF8100	i.MX 8X with DDR3L	MC33PF8100CFES	MC34PF8100CFEP
PF8200	i.MX 8X with LPDDR4	MC33PF8200DEES	-
PF8200	i.MX 8X with DDR3L	MC33PF8200DFES	-

i.MX Support

Operating Systems and Partners

Strongest Operating Systems for i.MX Applications Processors

Supplier	i.MX 6, 7 and 8 series ARM Cortex-A technology	i.MX 6SoloX, i.MX 7 and 8 series ARM Cortex-M technology
NXP Semiconductor	Linux Long Term Support (LTS) OS, supported in the Yocto Project and Android OS (Android Things on selected devices)	FreeRTOS AUTOSAR MCALs (separate license)
Mentor Embedded	Linux OS and Nucleus RTOS	Nucleus RTOS
Micrium (Silicon Labs)	uC/OS II and III RTOS, Micrium OS	uC/OS II and III RTOS, Micrium OS
QNX	Neutrino RTOS (background IP from NXP)	-
Green Hills	INTEGRITY RTOS (background IP from NXP)	-
Embedded Access	-	MQX RTOS
Express Logic	ThreadX RTOS (coming soon)	ThreadX RTOS (coming soon)
Microsoft	Win10 (pilot)	-
Timesys, Wind River, Canonical, and others	Commercial Linux	

Leadership Software – i.MX Linux Enablement

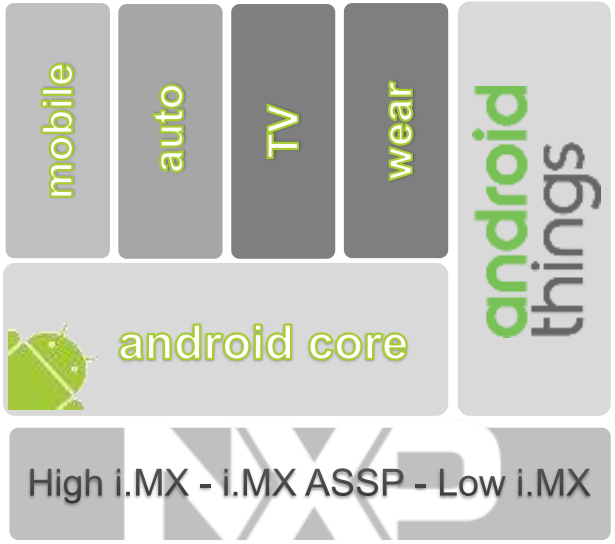
Silver Member

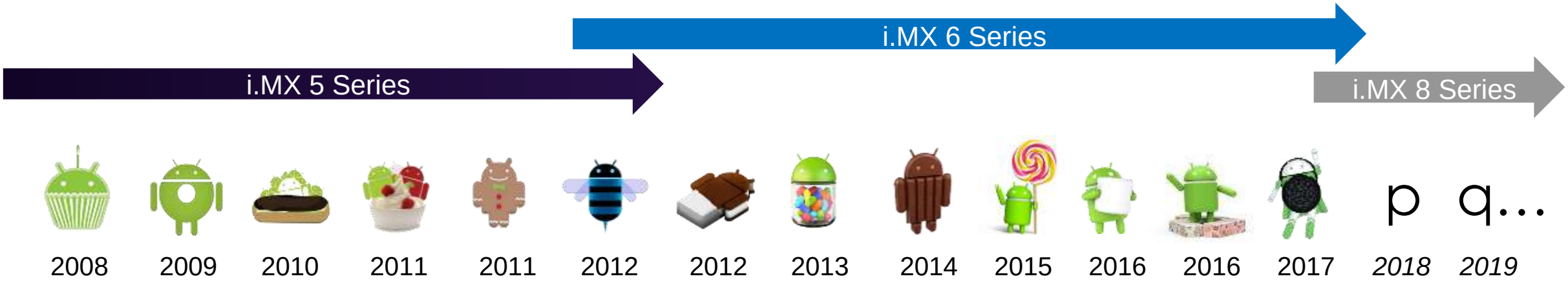
- Silver Member of Linux Foundation
- AGL Working Group Bronze Member
- Over the past 15 years shipping i.MX applications processors, there have been 39,000+ Linux downloads

- *Multiple i.MX 6 series customer engagements are using GENIVI solutions*
- *NXP has more compliant platforms than ANY semiconductor vendor*
- *Reference:* http://www.genivi.org/compliant-products

i.MX android Enablement

- Commitment: 13 Android OS versions released over past 9 years
- Broad Acceptance: 35,000+ downloads of Android BSPs to date
- Fast Development: ~4 months from development start to production release on multiple Android versions
- Cross Market Robustness: Automotive, Embedded/Industrial, Consumer, Things, TV
- Early Access Partner with Google for Android Automotive, Android Things
- Leadership: i.MX – FIRST Android system shipping in a top 5 OEM infotainment platform
- Multiple Android OS head units in OEM and aftermarket based on i.MX





Free RTOS

- Real-Time Operating System kernel with M
  processing overhead.

- Distributed under the GPL

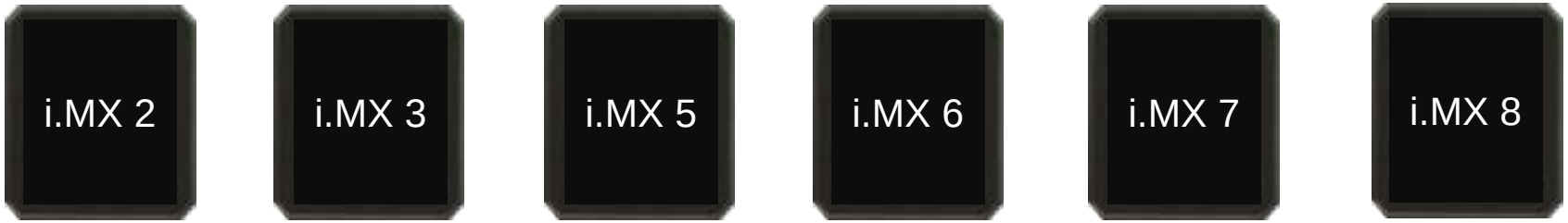
- Professionally developed, strictly quality controlled, robust, supported, free to use in commercial products

- http://www.freertos.org

https://en.wikipedia.org/wiki/FreeRTOS

i.MX – QNX Collaboration

- Commitment: Partnering with QNX on i.MX since 2008
- Customer Driven: QNX works directly with customers to provide the BSP
- Cross Market Robustness: Automotive, Embedded/Industrial
- Continued Support: Strong relationship and partnering between QNX and NXP Graphics support provided directly from NXP to QNX



NXP i.MX 8 AUTOSAR Solution

NXP provides software products where in-depth hardware knowledge is crucial – value-add software products such as AUTOSAR MCAL, Custom Complex Drivers, OS, Custom Self Test, application-specific libraries to address unique hardware features

Early Access Partners Launching with i.MX 8/8X Series

i.MX 8X Family: i.MX 8QuadXPlus, 8DualXPlus, 8DualX	i.MX 8 Family: i.MX 8QuadMax, 8QuadPlus
Digi International (USA, Global)	Advantech (Taiwan, Global)
Phytec (Germany, EMEA +AMEC)	BCM Advanced (USA, Taiwan, China, Denmark, Japan)
TQ (Germany, China, AMEC)	Congatec (Germany, USA, Taiwan)
Toradex (Switzerland, Global)	iWave (India, Japan, Global)
Variscite (Global)	Phytec (Germany, EMEA+AMEC)
Kontron (Global)	Toradex (Switzerland, Global)
	Variscite (Global)

i.MX 8QuadXPlus MEK System – Available

Part Number: MCIMX8QXP-CPU – works standalone w/o baseboard
Includes LVDS to HDMI adapter (IMX-LVDS-HDMI)

Overview
- NXP i.MX 8QuadXPlus
  - i.MX 8DualXPlus emulation on 8QuadXPlus
- NXP MMPF8100 PMIC
- 3 GB LPDDR4 memory, x32
- 32 GB eMMC 5.0
- 64 MB Octal SPI Flash
- 5.24” x 5.24” 8-layer PCB

Display Connectors
- 2x mini-SAS MIPI / LVDS connectors (Combo PHY)
- Camera MIPI-CSI through mini-SAS connector

Audio
- Audio Codec
- Microphone and headphone jacks

Connectivity
- 1x full-size SD/MMC card slot
- 10/100/1000 Ethernet port
- 1x USB 3.0 Type C

Debug
- JTAG connector
- Serial to USB connector

Expansion Connector
- M.2 Connector (PCIe, USB, UART, I2C and I2S)

Additional Features
- NXP 3-axis accelerometer & eCompass [not populated]
- NXP Gyroscope
- NXP Light Sensor
- NXP Pressure Sensor
- RGB LED
- Power supply
- No battery charger

OS Support
- Linux, Android and FreeRTOS BSPs from NXP
- Others: 3rd parties

Tools Support
- Lauterbach
- ARM (DS-5)

WiFi: (not included with kit)
- Murata WiFi module

Part Numbers: MCIMX8-8X-BB
Includes Audio Board (IMX-AUD-IO)

Connectivity
- 1x I2C Auxiliary Connector
- 1x Tamper Head
- 1x Parallel CSI Connector
- 1x UART, 2x CAN
- 1x uUSB OTG connector
- 1x Audio In Connector,
- 1x Audio Out Connector
- 1x 10/100/1000 Ethernet connector Muxed w/ Audio port)

Expansion Connector
- Arduino Connector / MikroBus Interface

i.MX 8QXP MEK Board & Accessories

i.MX 8QXP MEK CPU Card
Standalone Powered
MCIMX8QXP-CPU

MEK Common Baseboard
Works with i.MX 8QM& 8QXP
MCIMX8-8X-BB

OV10635 MIPI Camera
MCIMXCAMERA1MP

MIPI to HDMI
miniSAS Convertor
IMX-MIPI-HDMI

LVDS to HDMI
miniSAS Convertor
IMX-LVDS-HDMI

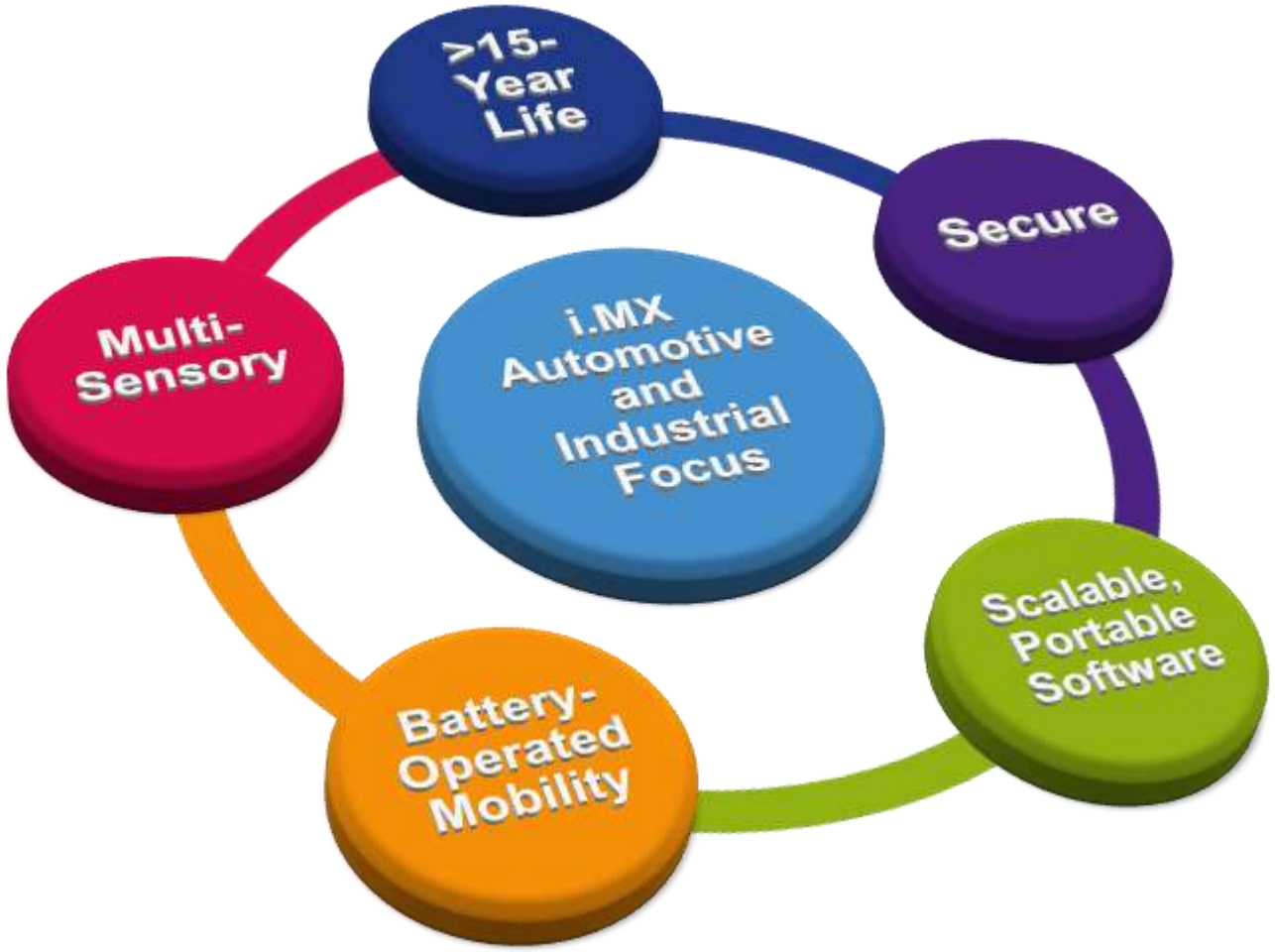
OV5640 MIPI CSI board
miniSAS based
MINISASTOCSI

BroadReach 100 Mbps PHY
IMX-RMII-BRPHY

Std 1Gbps PHY
IMXAI2ETH-ATH

BroadReach Switch (100Mb/s)
IMXAI2SWCH-NXP

i.MX 8 and 8X Applications Processors



Built for scalable, safe and secure multimedia and computing

- Sampling now for alpha and beta customers
- www.nxp.com/imx8

Thank-you for considering the i.MX 8 Series!

HANDS-ON LABS


NXP
SECURE CONNECTIONS
FOR A SMARTER WORLD