# I.MX IN AUTOMOTIVE

CARL CHIEN / FAE

SECURE CONNECTIONS
FOR A SMARTER WORLD

# i.MX Automotive Customers



- NXP has solid, long-standing customer relationships with nearly every automotive manufacturer and Tier 1 supplier in the world. We know what it takes to meet the stringent requirements of the global automotive market
- NXP has dedicated account teams for most car OEM's including BMW, GM, Ford, Chrysler, Daimler, VW/Audi, Fiat, Renault, PSA, Volvo, and Hyundai Kai

# WHY I.MX?
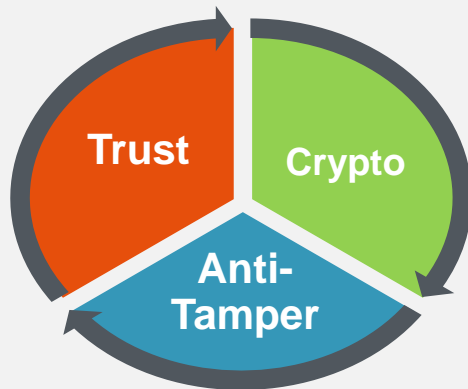
# i.MX Applications Processor Values

- **Scalability for Maximum Platform Reuse**
  - Pin compatibility and software portability
  - CPU (single/dual/quad, asymmetric), GPU, IO
  - Software: Linux, Android, Windows-embedded, RTOS

- **Trust**
  - Longevity: minimum of 10-15 years in all markets
  - Quality, robustness, zero-defect methodology
  - Security and Safety
  - Qualifications: Automotive AEC-Q100, JEDEC Industrial and Consumer

    www.nxp.com/productlongevity

- **Enablement for Ease of Use**
  - Industry-leading ecosystem, partnerships and support
  - Design collateral, distribution, communities
  - System solutions: SoC, sensors, memory, PMIC, connectivity
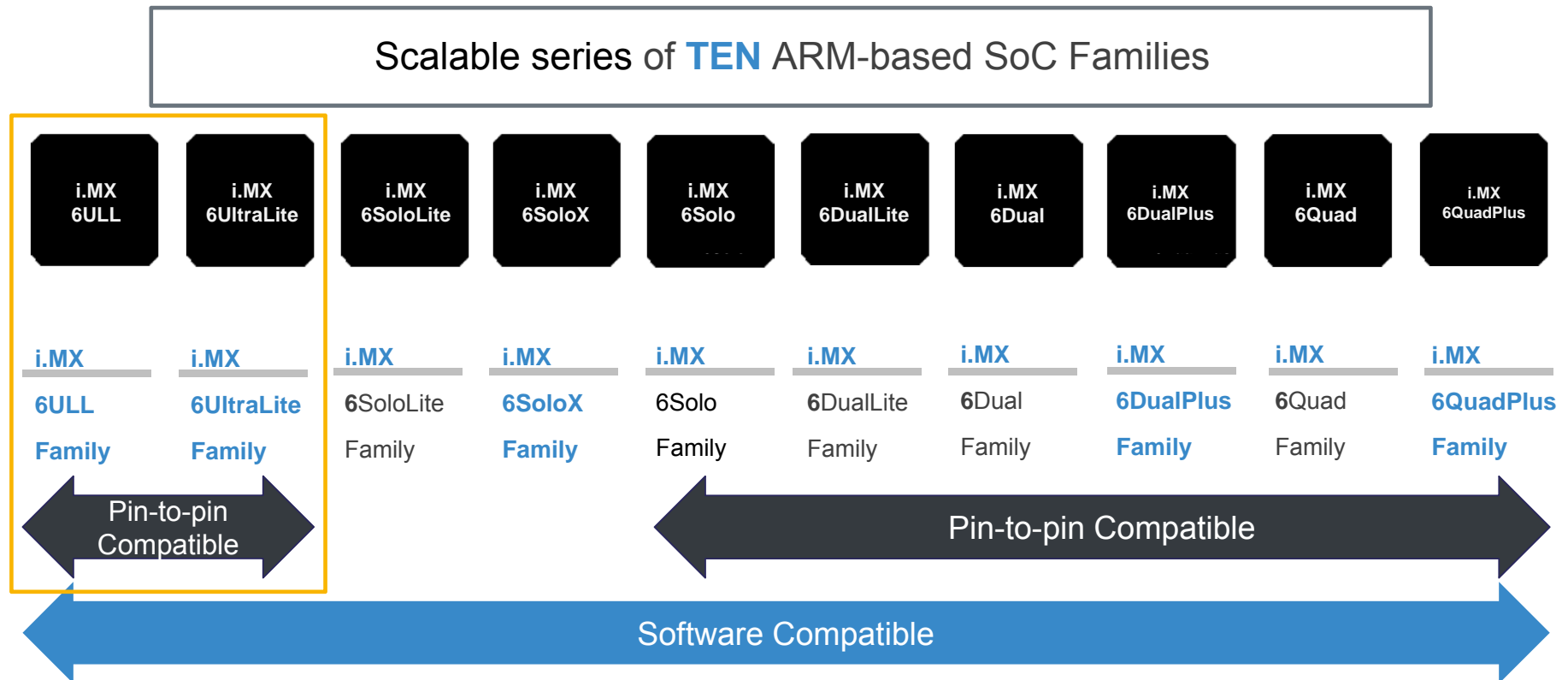
# WHY I.MX?
# SCALABILITY

# i.MX Roadmap
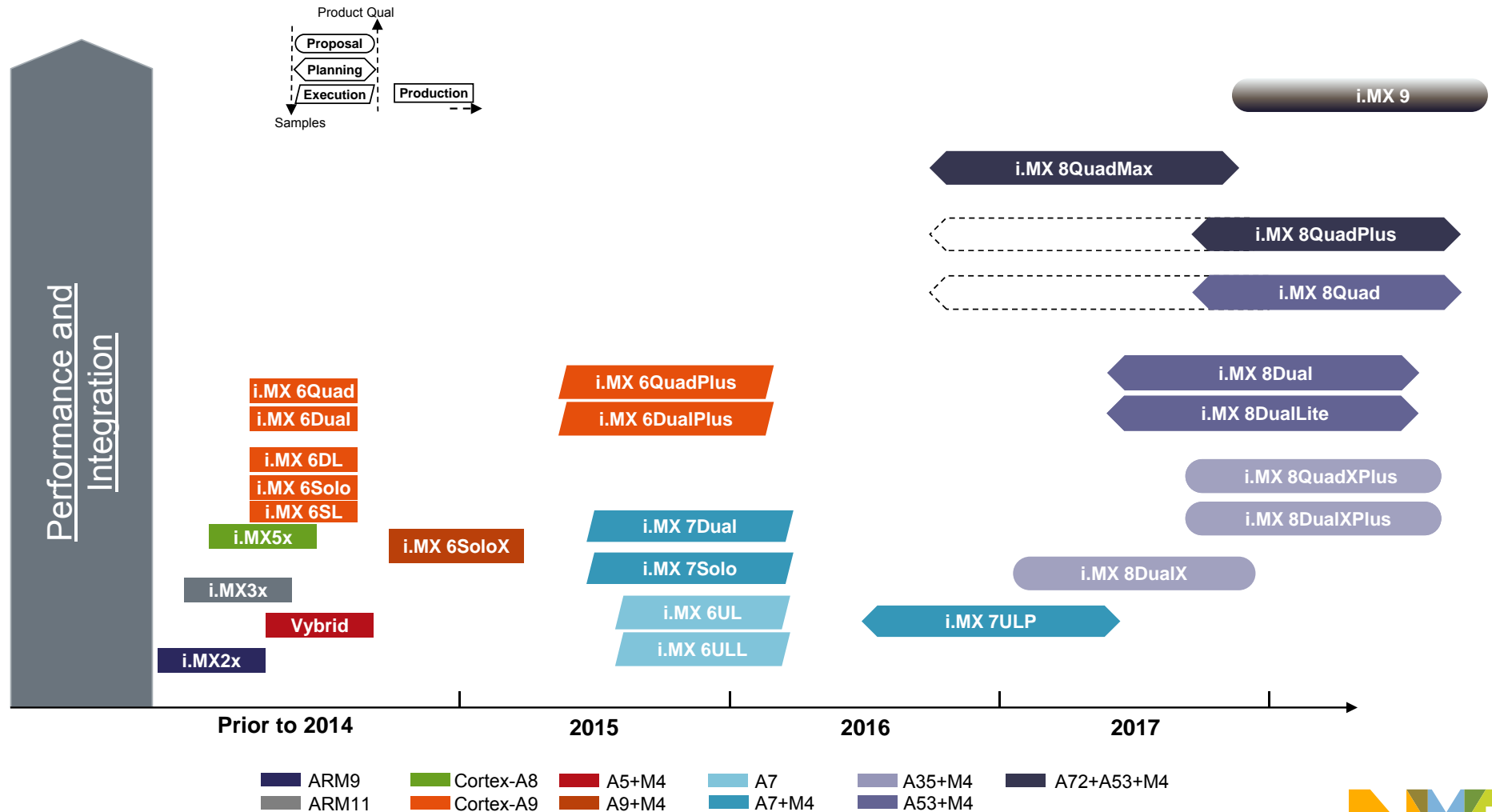
# i.MX 6 Series: Supreme Scalability and Flexibility
# Leverage One Design into Diverse Product Portfolio

Scalable series of **TEN** ARM-based SoC Families

| i.MX 6ULL | i.MX 6UltraLite | i.MX 6SoloLite | i.MX 6SoloX | i.MX 6Solo | i.MX 6DualLite | i.MX 6Dual | i.MX 6DualPlus | i.MX 6Quad | i.MX 6QuadPlus |
|---|---|---|---|---|---|---|---|---|---|

| i.MX 6ULL Family | i.MX 6UltraLite Family | i.MX 6SoloLite Family | i.MX 6SoloX Family | i.MX 6Solo Family | i.MX 6DualLite Family | i.MX 6Dual Family | i.MX 6DualPlus Family | i.MX 6Quad Family | i.MX 6QuadPlus Family |
|---|---|---|---|---|---|---|---|---|---|

Pin-to-pin Compatible

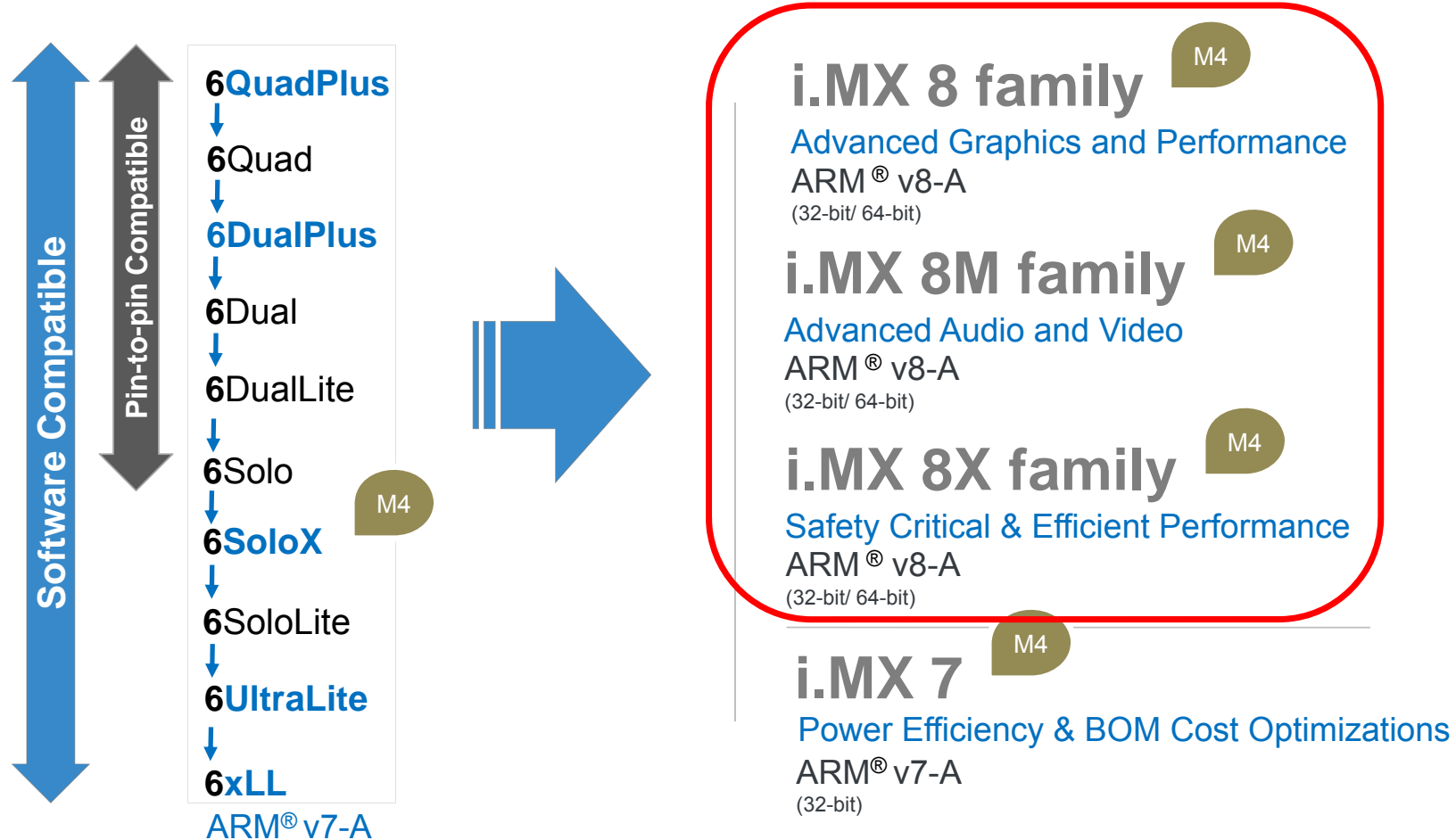Pin-to-pin Compatible

Software Compatible

Expanded series for performance, power efficiency and lower BOM
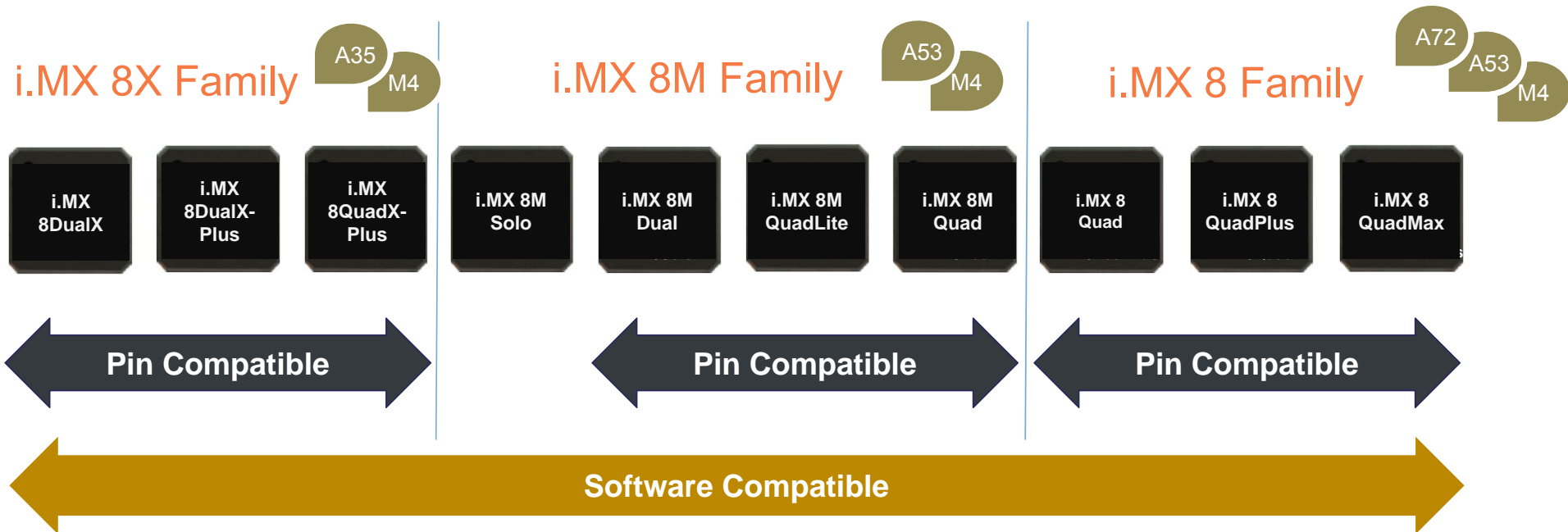
# i.MX 8 FAMILY

# i.MX 8 Series: 3 families of parts with targeted features

# i.MX 8 Series: Supreme Scalability and Flexibility

NEW

Scalable series of **THREE** ARM-based SoC Families

**i.MX 8X Family**  A35  M4

**i.MX 8M Family**  A53  M4

**i.MX 8 Family**  A72  A53  M4

| i.MX 8DualX | i.MX 8DualX-Plus | i.MX 8QuadX-Plus | i.MX 8M Solo | i.MX 8M Dual | i.MX 8M QuadLite | i.MX 8M Quad | i.MX 8 Quad | i.MX 8 QuadPlus | i.MX 8 QuadMax |

◄ **Pin Compatible** ►   ◄ **Pin Compatible** ►   ◄ **Pin Compatible** ►

◄ **Software Compatible** ►

NXP

# i.MX 8 Family

## Up and To The Right

| | CPU | GPU | Virtual | Vision | Display | VPU | DDR |
|---|---|---|---|---|---|---|---|
| i.MX 8QMax | 3.5x | 5x | New | 10x | 4x | 8x | 3x |
| i.MX 8QPlus | 2.5x | 2.5x | New | 5x | 4x | 8x | 3x |
| i.MX 8Quad | 1.5x | 2.5x | New | 5x | 4x | 8x | 3x |

i.MX 6QuadPlus

# i.MX 8 - *The Dance of the Logos*

PCI EXPRESS™ **3.0**

SERIAL ATA **3**

USB **3.0**

**LPDDR4**

**OctoSPI**

**Full upgrade across all major peripheral classes**

I²C BUS *3.4Mbps*

HDMI HIGH-DEFINITION MULTIMEDIA INTERFACE **2.0**

DisplayPort

((HDCP)) **2.2**

MIPI *DSI*

MIPI *CSI*

*embedded* DisplayPort

NXP

# i.MX 8 FAMILY
## eCOCKPIT SOLUTIONS

# Full Integration
**eCockpit on i.MX 8 Family**



**Instrument Cluster**
i.MX , i.MX 8, S32

**Infotainment**
i.MX 7, i.MX 8

**CLOUD**

Driver and Passenger Mobile Devices

**Telematics**
i.MX 6, i.MX 7

OEM Cloud

**V2X**
i.MX 6, i.MX 7

V2I Cloud

**Rear Seat Entertainment**
i.MX 6, i.MX 8

**Audio Amplifier**
i.MX 6, i.MX 7, S32

ADAS
S32
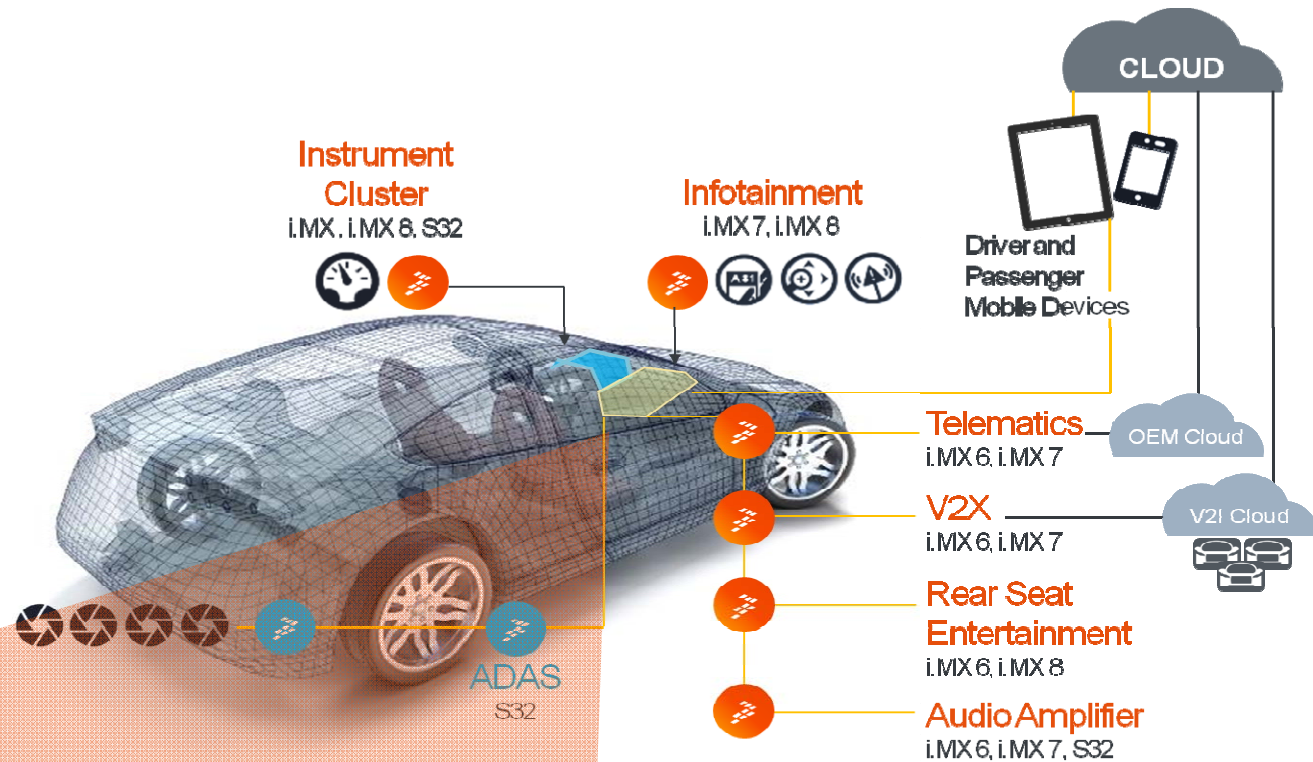
**e-cockpit**
i.MX 8 Series
Cluster, Heads Up Display,
Infotainment, Driver Awareness

http://www.nxp.com/products/microcontrollers-and-processors/arm-processors/i.mx-applications-processors/i.mx-8-processors/i.mx-8-family-processors-transforming-inter-actions-in-ways-youve-never-imagined/i.mx-8-family-arm-cortex-a53-cortex-a72-virtualization-vision-3d-graphics-4k-video:i.MX8?tab=Design_Support_Tab
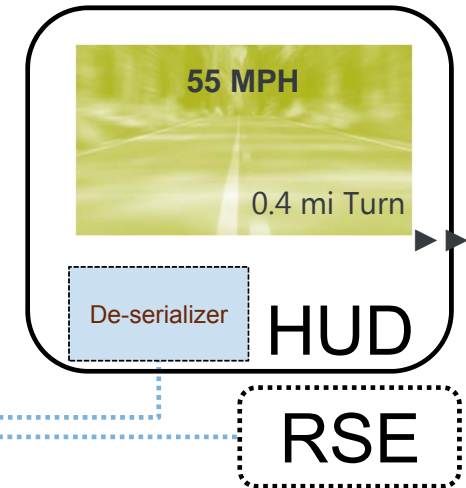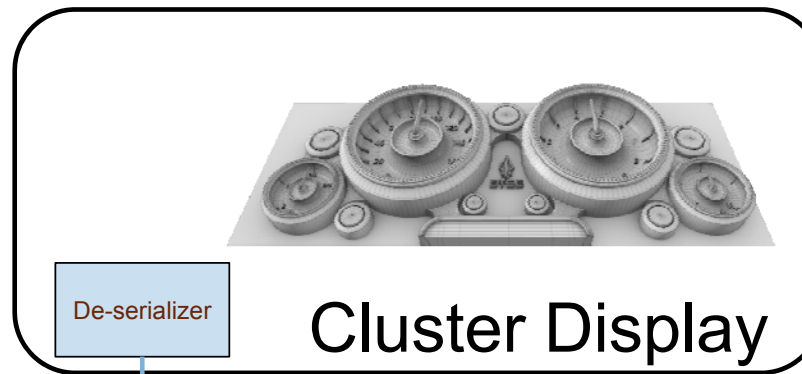
# Before eCockpit … Function Duplication over Multiple Platforms

# i.MX 8 eCockpit Design example

## Single Supplier for All Graphics and Display Processing

**Infotainment Display**

**Cluster Display**

De-serializer

**55 MPH**

0.4 mi Turn

De-serializer **HUD**

**RSE**
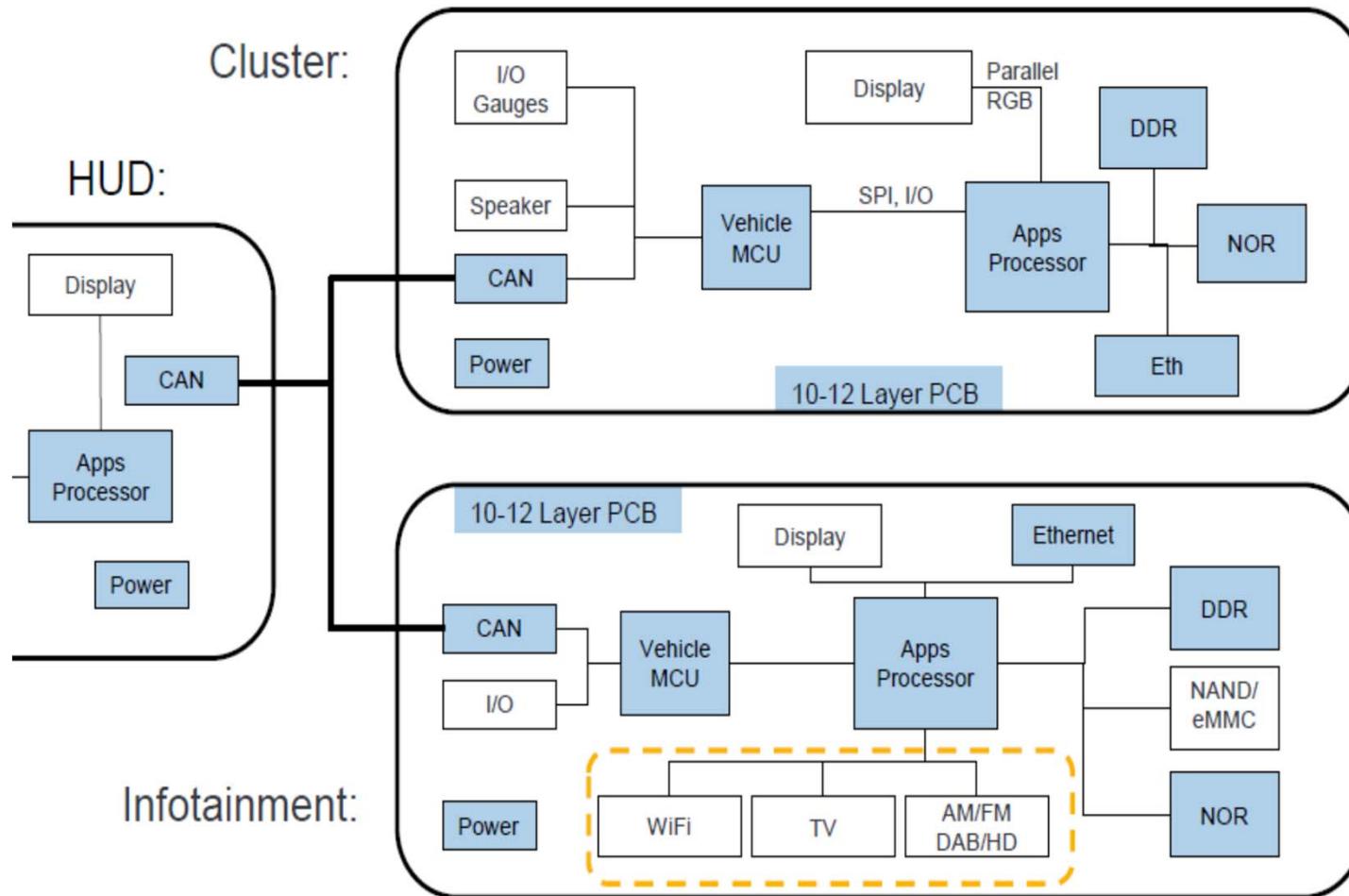
**Eliminated:**

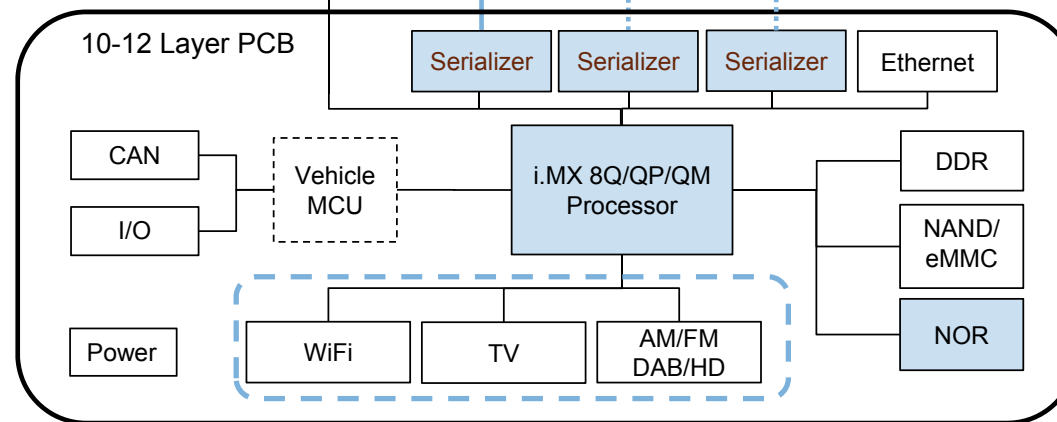| |
|---|
| ECU housing and design NRE |
| 10 layer cluster PCB |
| 5-6 power supplies / circuit protection |
| Applications Processor & Software |
| 256MB DDR / 128MB NOR |
| Cluster VMCU + ASIL B OS |
| Speaker |
| CAN Tx/Rx and harness |
| Debug ports and hardware |
| Discrete components and connectors |

**10-12 Layer PCB**

Serializer | Serializer | Serializer | Ethernet

CAN

I/O

Vehicle MCU

i.MX 8Q/QP/QM Processor

DDR

NAND/ eMMC

Power

WiFi | TV | AM/FM DAB/HD

NOR
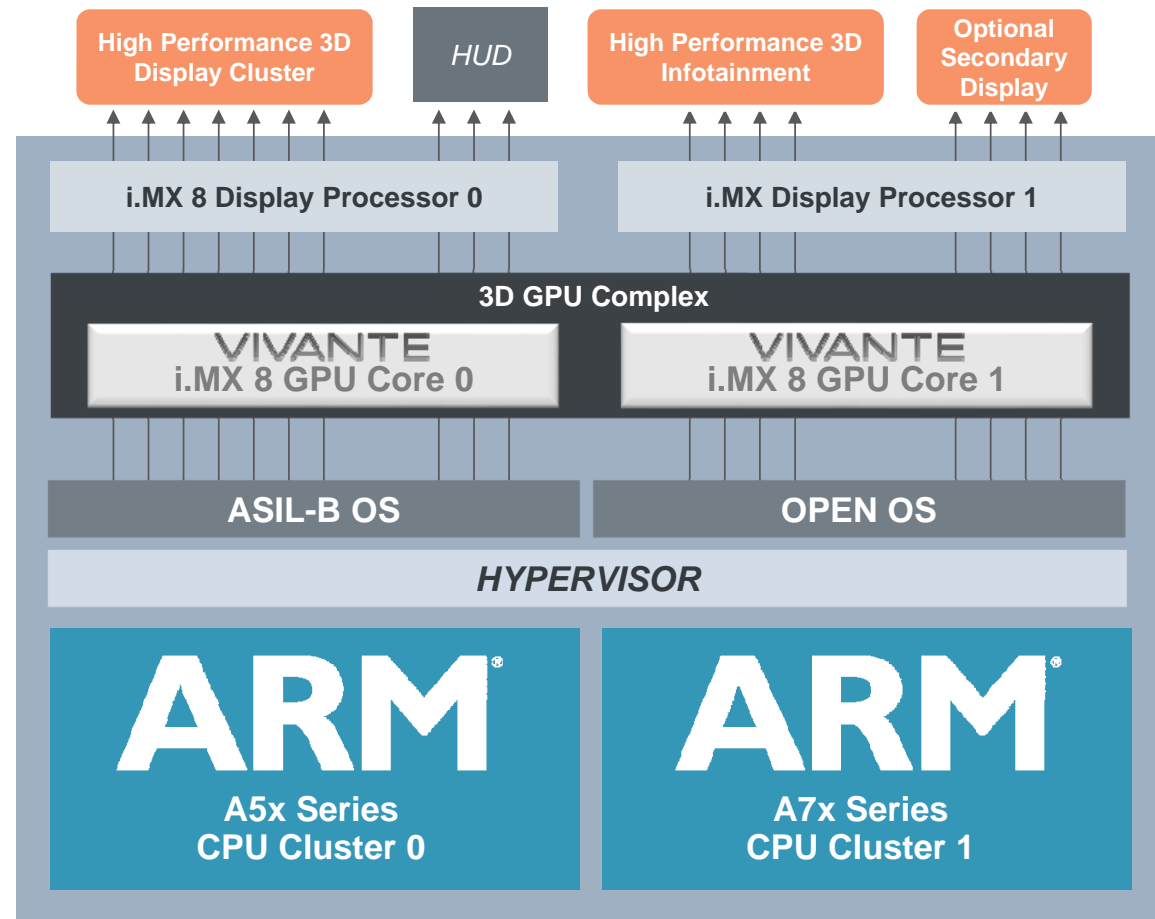
**Additional e-Cockpit ECU requirements:**

| |
|---|
| Advanced Applications Processor (Delta from Infotainment SoC) |
| ASIL B ARM Hypervisor |
| Additional DDR / Additional program NVM |
| Cluster plus optional HUD LVDS Serializers |
| Cluster plus optional HUD Deserializers |

**NXP**

# i.MX 8 Family eCockpit Solutions

**Advantages**

- *Dual Independent Display Controllers*

- *Configurable GPU Cores*
  - *Single Monolithic GPU*
  - *Dual Independent GPUs*

- *Industry Standard ARM enablement*

- *SoC Level Virtualization*

High Performance 3D Display Cluster

HUD

High Performance 3D Infotainment

Optional Secondary Display

i.MX 8 Display Processor 0

i.MX Display Processor 1

3D GPU Complex

VIVANTE i.MX 8 GPU Core 0

VIVANTE i.MX 8 GPU Core 1

ASIL-B OS

OPEN OS

*HYPERVISOR*

ARM A5x Series CPU Cluster 0

ARM A7x Series CPU Cluster 1

# i.MX SOFTWARE

# Leadership Software – i.MX Linux Enablement

**i.MX 6 and 7 series GA on Linux kernel 4.1 (Oct/16)**

- 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

**Silver Member**

# i.MX **Android** Enablement

**Commitment:** **11** *(soon to be **12**)* Android OS versions released over past **8** years

**Broad Acceptance:** **25,000+ downloads** of BSP to date

**Fast Development: ~4 months** from development start to production release on multiple Android versions

**Cross market robustness: Automotive, Embedded/Industrial, Consumer**

**Continued support:** New OS releases for **min. 2 years** after silicon production

**Leadership:** i.MX – only Android system shipping in a **top 5 OEM infotainment platform** today

**Android Nougat coming 1H/17**

| 2008 | 2009 | 2010 | 2011 | 2011 | 2012 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |

# 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** | Yocto Linux OS and Android OS (Brillo OS on selected devices) | FreeRTOS |
| **Mentor Embedded** | Linux OS and Nucleus RTOS | Nucleus RTOS |
| **Micrium** | uC/OS II and III RTOS | uC/OS II and III RTOS |
| **QNX** | Neutrino RTOS | - |
| **Green Hills** | INTEGRITY RTOS | - |
| **Adeneo** | Windows Embedded | |
| **Express Logic** | ThreadX RTOS (coming soon) | ThreadX RTOS (coming soon) |

# i.MX HARDWARE

# i.MX 6 Reference Designs (with Production Silicon)

- **All Boards NXP designed**
- **All Boards NXP supported**
- **Common set of boards for 6Q/D/DL/S**
- **SoloLite will have its own EVK**

| | i.MX 6Quad<br>• Dual DDR | i.MX 6Dual<br>• Dual DDR | i.MX 6Dual Lite<br>• Dual DDR<br>• EPD | i.MX 6Solo<br>• Single DDR<br>• EPD | i.MX 6SoloLite<br>• Single DDR<br>• EPD |
|---|---|---|---|---|---|
| **SABRE–AI for Auto ($1499)** | ✔ | | | ✔ | |
| **SABRE Platform for Smart Devices ($999)** | ✔ | | ✔ | | |
| **SABRE Board for Smart Devices ($399)** | ✔ | | | | |
| **i.MX 6SL EVK ($599)** | | | | | ✔ |

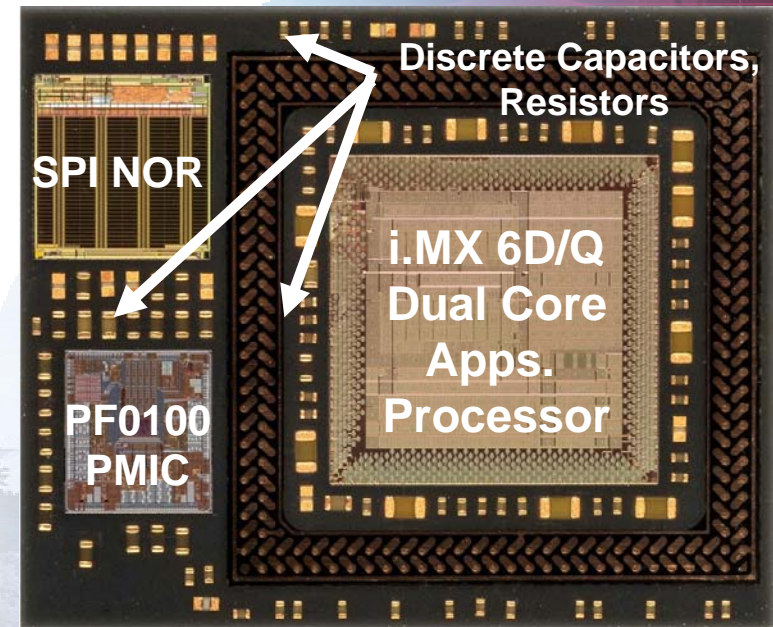**i.MX 6 maximizes use of reference boards across derivative parts**
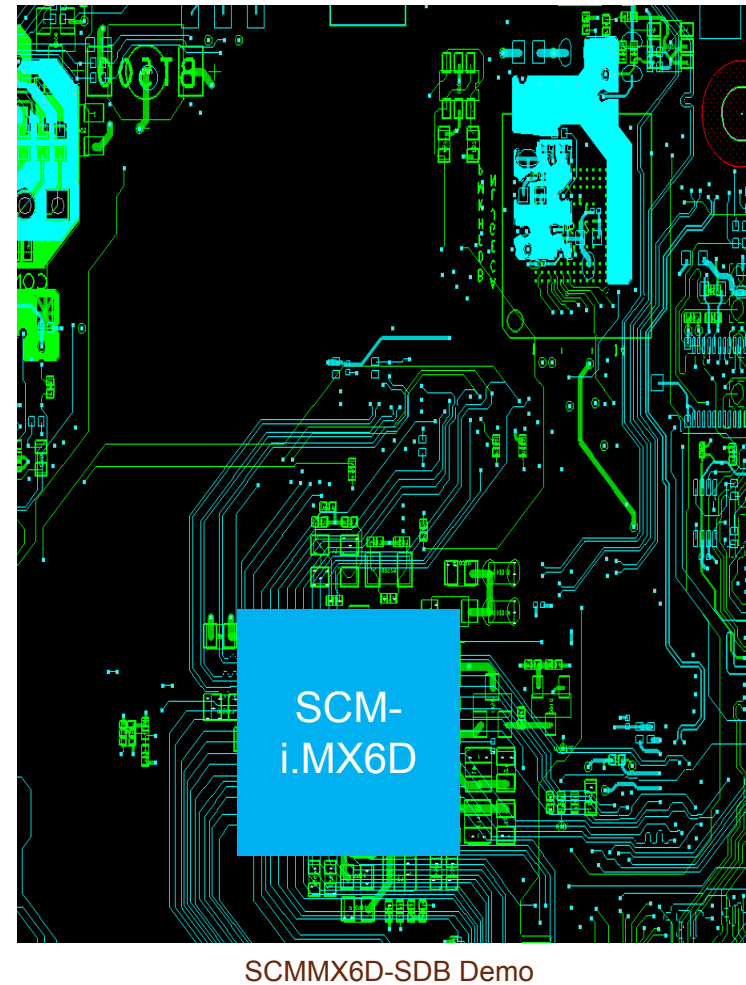
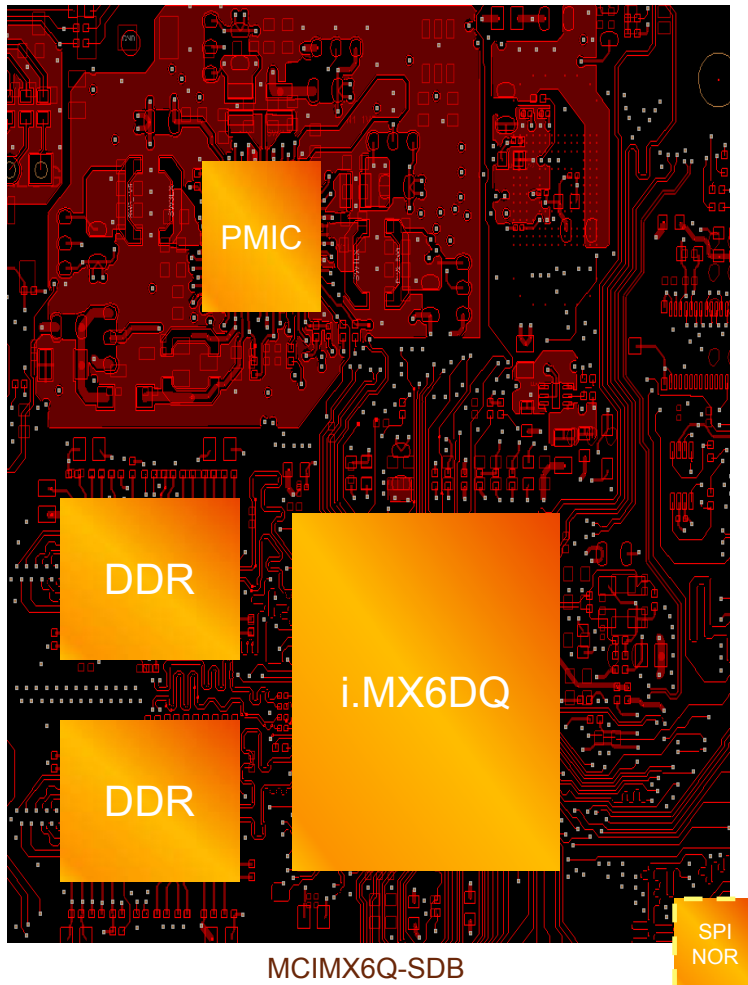# Small Package Options for i.MX Processors

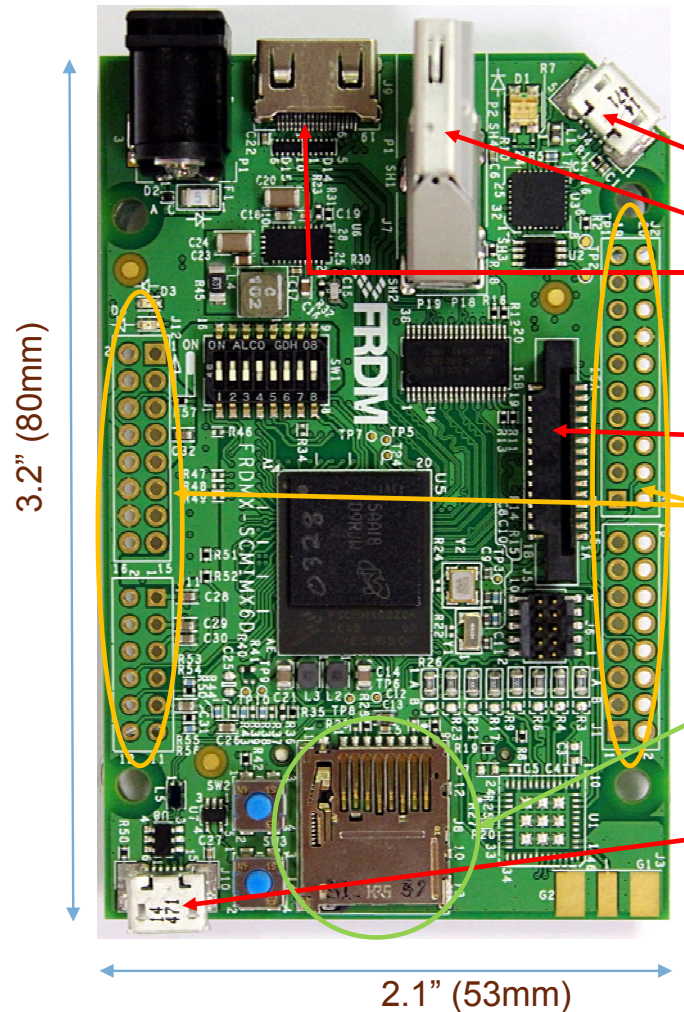| i.MX product families | Smallest Ball Grid Array (BGA) planned | Package on Package (PoP) | Single Chip Module (SCM) | 3rd-party System on Module (SOM) |
|---|---|---|---|---|
| i.MX 6Quad i.MX 6Dual | 21x21, 0.8p, FC-PBGA 624 | 12x12, 0.5p, FC-CSP 569 | 17x14, 0.65p, 1GB or 2GB LPDDR2, 16MB SPI NOR + PMIC | Many |
| i.MX 6SoloX | 14x14, 0.65p 17x17, 0.8p | Not planned | Launching soon | Several |
| i.MX 6UltraLite | 9x9, 0.5p 14x14, 0.8p | Possible if good business case | TBD | Several |
| i.MX 7Dual i.MX 7Solo | 12x12, 0.4p 19x19, 0.75p | Possible if good business case | TBD | Several |

# Introducing the SCM-i.MX 6D/6Q

- It's the **world's smallest single chip system**.

- Solution integrates **fully featured dual-core or quad-core processor**, fully integrated power management system, memory, and enhanced security features in a single chip system module, all in **the size of a dime.**

- **Breakthrough time to market**—get there in about 6 months or less.

- **Highly integrated** with NXP's high-end dual and quad core apps processor, which provides full suite of features and functions addressing broad range of customer needs.

- **Unprecedented ultra-small form factor** with greater than 50% reduction over current discrete solutions.



Discrete Capacitors, Resistors

SPI NOR

i.MX 6D/Q Dual Core Apps. Processor

PF0100 PMIC





Enables for 1GB or 2GB PoP LPDDR2 memory
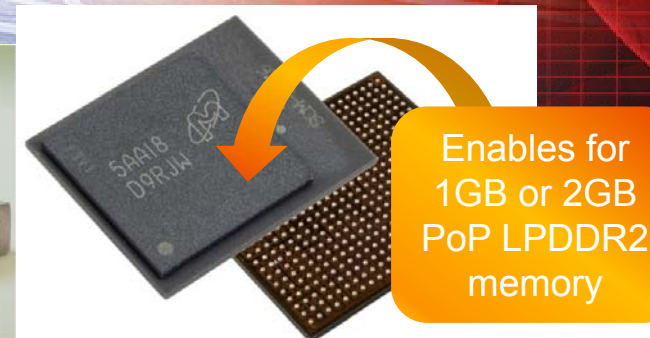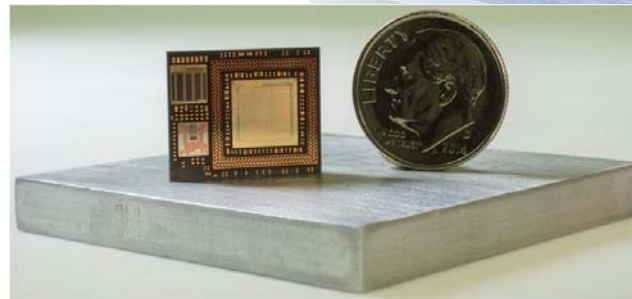
# PCB Space Reduction Achieved by SCM-i.MX 6Dual/6Quad



MCIMX6Q-SDB

SCMMX6D-SDB Demo

# SCM-i.MX 6Dual/6Quad Quick Start Board



- SCM-i.MX6D (1GB LPDDR2 + PMIC PF0100 + 16MB SPI NOR)
- Micro-SD card socket
- Standard SD card socket
- HDMI connector
- JTAG (10 pin)
- USB (UART to USB serial debug)
- USB device mode
- MIPI Camera connector (compatible with Raspberry Pi 2 camera module)
- LVDS display (w/ cap. touch) connector (compatible with Element14 9.7" LCD display with mini-HDMI connection)
- Wi-Fi available via SDIO interface* (compatible with Murata SD module)
- Arduino R.3 header compatible (no ADC)
  - AUDMUX, SPDIF, ENET (10/100), SPI, UART muxed with Arduino headers.

# i.MX ECOSYSTEM

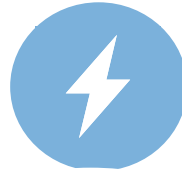# i.MX Ecosystem. Many Markets, Many Choices
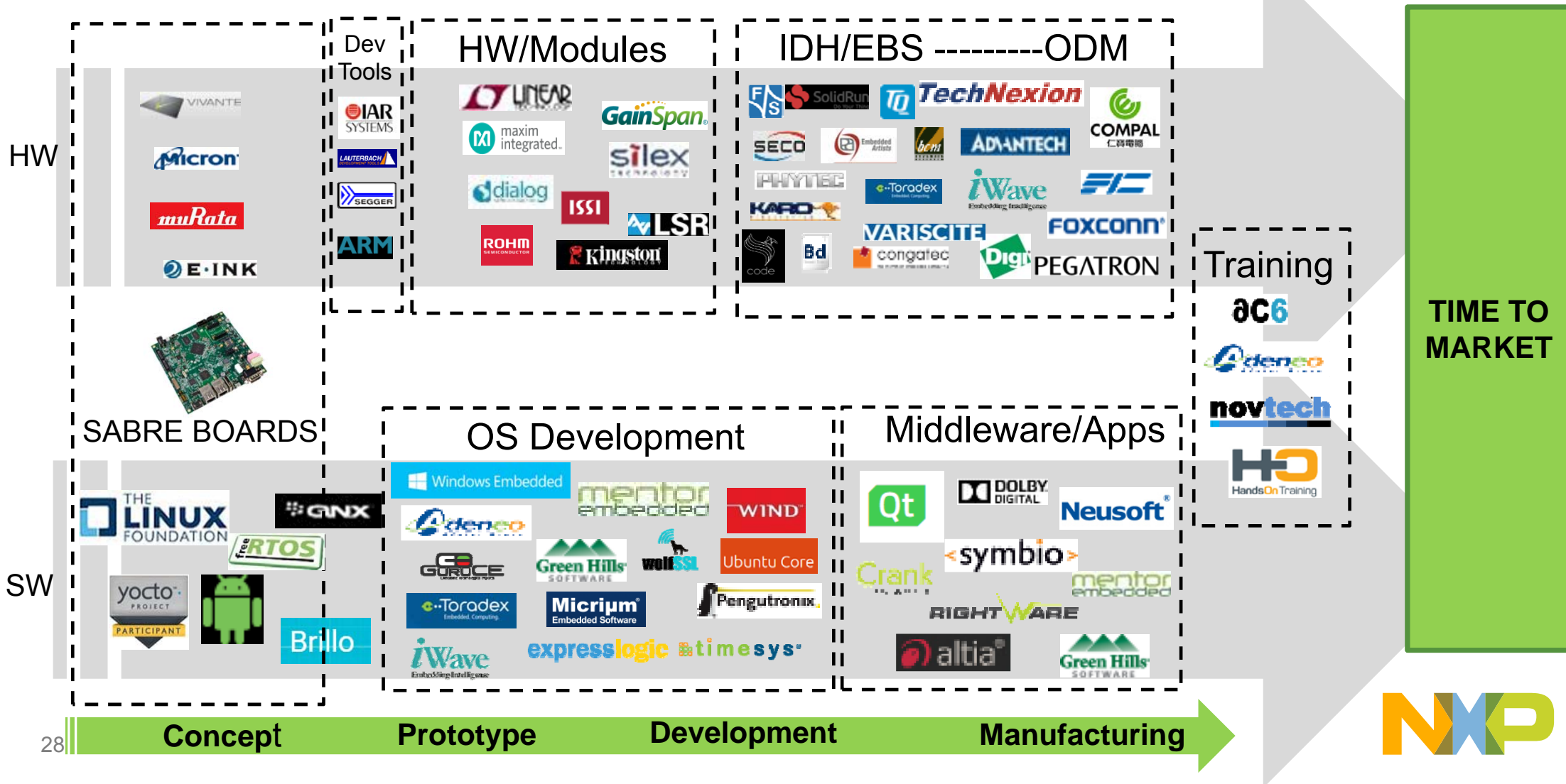
# MICR Software and Service (MSS)

# Software, Professional Support & Services

## Complimentary Software & Tools

Kinetis Design Studio, Software Development Kit, Pin Config, Power Estimator/Analyzer, Bootloader, RTOS, Linux & Android BSPs, Manufacturing tools…
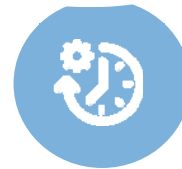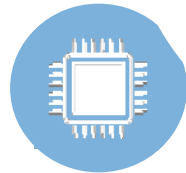
## Professional Services

Managing Skills Gaps & Engineering Capacity
Global Staffing Capability
Vested Interest in Mutual Success
Graphic, Security, Linux/Android, Cloud.

## Complimentary Support

NXP Development and Reference Boards
NXP Communities
Technical Information Center
Systems Engineering (Apps) Organization
Distributor and Field Application Engineering

**Embedded Processing Solutions**

## Hardware Services

1st Time Boot
Schematics & Layout Review
Design Simulation

## Software Products / Technology

AVB, Miracast, HDCP2.x, TRLE, TEE, Home Kit, CarPlay, Android Auto, MICROEJ AUTOSAR, GPU Driver optimizations, AGL, Genivi, XBMC, HAB
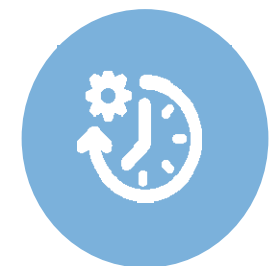
## Professional Support

Risk Reduction
Fast Answers
Hot Fixes
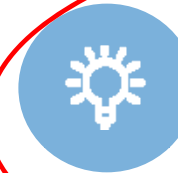
# Available Software Products / Technologies

- **AVB (**Audio Video Bridging)  (nxp.com/AVB)

  – Delivering high quality A/V over Ethernet

  – End node (full-stack or audio only) and AVB bridge solutions available

- **TEE** (Trusted Execution Environment) (nxp.com/TEE)

  – Used to implement  a safe zone within the application processor

  – TEE offers protection against software attacks in a rich OS environment (like Android or Linux)

- **TRLE  (**Tessellation Run Length Encoding) (nxp.com/TRLE)

  – NXP's TRLE technology provides an efficient, lossless image compression that leverages use of GPUs while minimizing memory requirements.

Android™ Auto, Apple® CarPlay(TM), AUTOSAR® MCAL for i.MX Applications Processors, MIRACAST™ for Linux, Homekit / Mfi, Thread Connectiviry Stack

Check our website for more information:  www.NXP.com/SWtech

# MSS Case Study

# AVM Platform

## Solution

**i.MX6 D
i.MX6 DL
+
Linux 3.14.28 BSP
+
Fast Boot/HAB
+
Professional
Services**

| Function | Required Time (sec) | Measure Time (sec) i.MX6 D 3.0.0 + Audio Patch |
|---|---|---|
| Splash screen | 0.5 | 0.266 |
| Park assist Camera Video | 1.5 | 1.39 |
| Park assist Camera Audio | 1.5 | 1.41 |
| Splash Video | 2.0 | 1.6 |
| Park assist HMI | 4.6 | 2.8 |



**Achievements:**

- Fast boot (with HAB) for splash video, rear view camera and early audio
- Provided example Qt QML park assist assist application.
  - Cameras are displayed prior to HMI boot, then HMI is added without flicker in camera feeds.
- Provided requested features on 2 different customer boards
- Assisted customer with integration of HMI strategy into their application.

# Telematics platform

**Solution**

**i.MX6S/Q**
**+**
**Linux BSP**
**+**
**Professional Services**



## Accomplishments

- Development of a Test and Debug environment
- Support and maintenance of the Linux kernel

# Telematics Platform

## Solution

**i.MX6 DL
+
Linux 3.14.28 BSP
+
Professional
Services**



**Achievements:**

- Custom BSP port to customer board including :
  - IEEE1588 Timestamping
  - Spansion NOR H/W protection PPB (persistent protection bit) & Automatic ECC
  - USB SIM reader
- Optimized Ethernet PHY
  - Support BCBR PHY to link up within 150ms after Power-up
- Support for single image file and alternate image programming method

# Instrument Cluster

**Solution**

**i.MX6DualPlus**
**+**
**Linux BSP**
**+**
**Professional Services**

**Achievements:**

- Captured business away from competitor
- Hit delivery milestones on time!

# Instrument Cluster

### Solution

**i.MX6(DL/DP)**
**+**
**Integrity BSP**
**+**
**3D Graphics**
**+**
**Professional Services**



**Achievements:**

- Qualified graphical stack to secure customer release plan
- Delivered the first ports to GHS Integrity for the 4.x and 5.x version of the driver, supporting i.MX6DQP and i.MX6DL
- Hardened and stabilized the Graphical stack

# BMW Backup Camera

**Solution**

**i.MX 6DualLite**
**+**
**Autosar MCALs**
**+**
**Integration Consulting**



**Achievements:**

- Provided RTM Release and Support
- Assisted Partner/Customer with integration into their application.

# Payload Camera

**Solution**

**i.MX6D**
**+**
**Linux BSP**
**+**
**Professional Services**

# AVB Audio switch

## Solution

**i.MX6Quad
+
Linux BSP
+
AVB audio
+
Professional
Services**

**Achievement:**

- 1st commercial solution with Audio-Video Bridging

# Micro Projector

**Solution**

**i.MX6 D**
**+**
**Linux 3.10.53 BSP**
**+**
**Miracast Sink**
**+**
**HDCP 2.2**
**+**
**MSFT PlayReady**
**+**
**Professional Services**

# Gas Pump





**Solution**

**i.MX6 D
+
Linux 3.14.28 BSP
+
MQX 4.2.0 BSP with OpenAmp
+
Professional Services**

**Achievements:**

- Innovation project with MQX+ Linux running on each core of i.MX6 D with intercore communication
- Major cost reduction in Hardware ( 5 boards reduced to 1 )
- Due to service team involvement, NXP will displace competitor device with Kinetis for final production solution.

# Audio Switch

## Solution

**i.MX6 Q**
**+**
**Linux 3.14.28 BSP**
**+**
**Professional Services**



**Achievements:**

- Rewrite audio drivers to use FIQ for switching at lower level instead of user space.
- Create audio drivers for audio sound cards and codecs used on customer board: AK5384, AK4425, AK4122, TAS5558
- Enable SPDIF
- Extended support for 96kHz for audio I/O
- Extend audio routing to provide the ability to take any of the four wired inputs (2 TOS link, 2 Analog), and switch them to any of the 6 outputs (4 amplified, 1 Digital COAX, 1 Analog).

# Enterprise IP Phone



## Requirements

Port Android support to existing production quality HW platform
Develop and integrate middleware customer specific features into Android: Networking, Security Connectivity: BT
Provide support until production launch (planned in Q1'17)

## Achievements

Established NXP as a platform provider
4 intermediate milestone releases made on time to customer

## Solution

**i.MX6DL**
+
**Android BSP**
+
**Networking (Eth)**
+
**Security**
+
**Professional Services**

# i.MX AUTOMOTIVE

# Automotive Solutions

## Infotainment



## Instrument Cluster



## Surround View Park Assist System
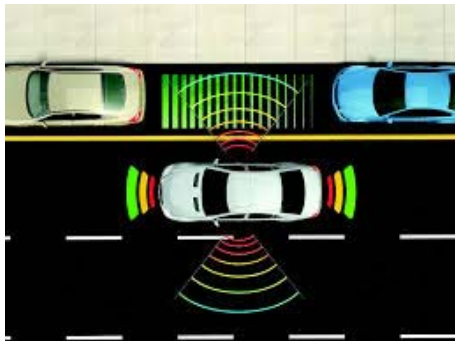


## Smart Key

# HUMAN MACHINE INTERFACE
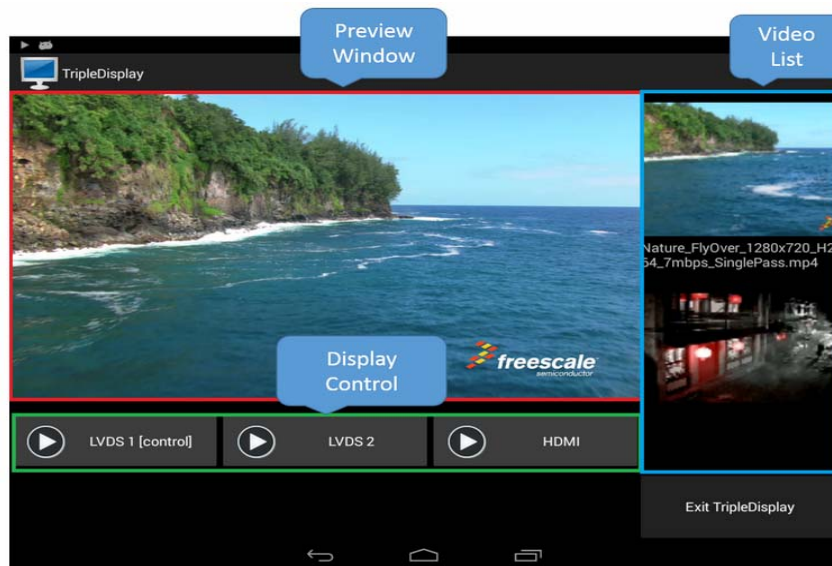
## ANDROID TRIPLE DISPLAY

# Android Triple-Display

- The user can play different video by clicking control button for specifying the target device

Triple display output
- 1x 1080p HDMI
- 2x 720p LVDS



Main Display UI

# Multiple Display Applications



**Rear Seat Entertainment**
- Media Playback
- TV
- Games
- Controls

**KTV**
- HDMI TV
- VOD
- AD.





**Advertising Machine**

# HUMAN MACHINE INTERFACE

## *MIRACAST SOURCE/SINK*

# Miracast

**Miracast** is a peer-to-peer wireless screencast standard formed via Wi-Fi Direct connections in a manner similar to Bluetooth. It was created by the Wi-Fi Alliance and billed as an open alternative to Apple's AirPlay Mirroring. Both the sending and receiving devices must be Miracast certified for the technology to work.

http://www.wi-fi.org/wi-fi-certified-miracast%E2%84%A2

Miracast allows a portable device or computer to send, securely, up to 1080p HD video and 5.1 surround sound (AAC and AC3 are optional codecs, mandated codec is LPCM — 16 bits 48 kHz 2 channels).

# Miracast Source/Sink Example

# Miracast Source/Sink from FSL BSP

- Android Jelly Bean 4.2 or later version adds Miracast Source support by default. NXP expands the software to support Miracast Sink:
    - Wi-Fi P2P
    - RTSP streaming decoding (up to 1080P resolution)
    - Compatible for variable Wi-Fi cards
        - Silex AR6233X SDIO card (Atheros AR6103)
        - Realtek 8723AS SDIO card
    - Delivery:
        - Freescale proprietary java archive and native library
        - Simple APIs to customize  Miracast Sink Application.
        - Demo Sink Application
    - Non- Supported features:
        - TDLS (Tunneled Direct Link Setup)
        - HDCP (High-bandwidth Digital Content Protection)

            https://community.freescale.com/docs/DOC-102180

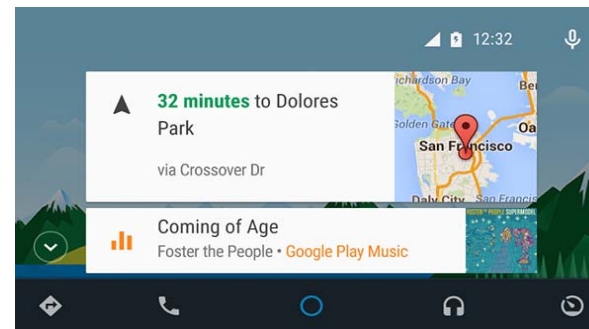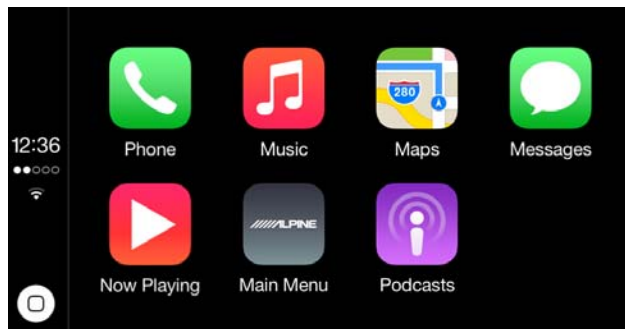# HUMAN MACHINE INTERFACE
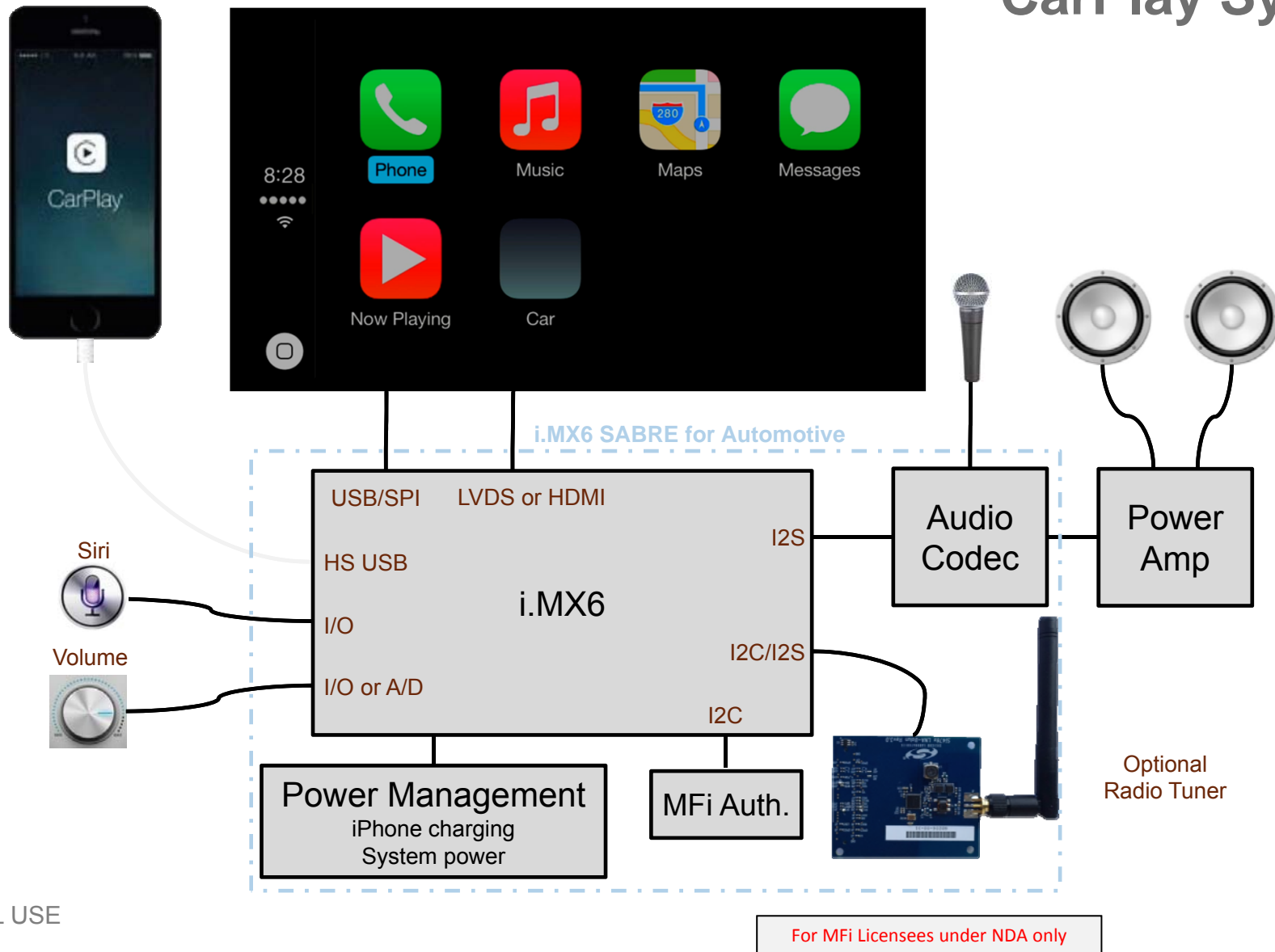
## *CARPLAY AND ANDROID AUTO*

# Introduction to Apple CarPlay and Android Auto

Apple CarPlay and Android Auto provide a user interface optimized for the driver and "projected" onto the automotive infotainment system, almost entirely controlled by the phone.
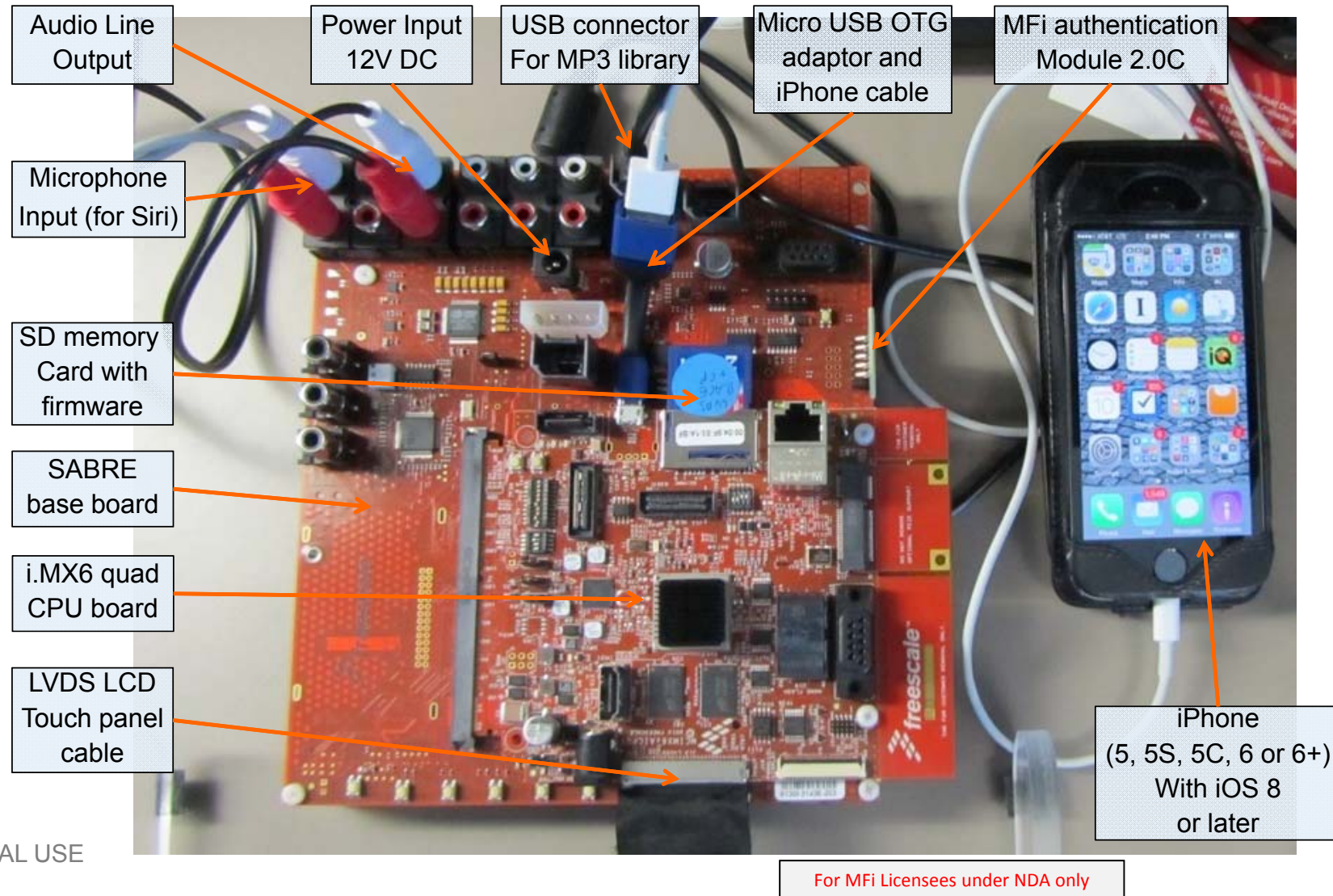
- The functionality is limited to that appropriate for the driver
  - No video playback, no emails, no facebook, no web browsing, no typing

- Key functionality
  - Navigation, hands-free phone, audio playback, hands-free messaging
  - many functions are voice activated (Siri or Google Now)
  - user interface icons are large and Apps are simplified

# CarPlay System

i.MX6 SABRE for Automotive

USB/SPI    LVDS or HDMI

HS USB

I/O

I/O or A/D

**i.MX6**

I2S

I2C/I2S

I2C

Siri

Volume

**Audio Codec**

**Power Amp**

Optional Radio Tuner

**Power Management**
iPhone charging
System power

**MFi Auth.**

# Apple CarPlay Demo Setup: Overall System



Audio Line Output

Microphone Input (for Siri)

Power Input 12V DC

USB connector For MP3 library

Micro USB OTG adaptor and iPhone cable

MFi authentication Module 2.0C

SD memory Card with firmware

SABRE base board

i.MX6 quad CPU board

LVDS LCD Touch panel cable

iPhone (5, 5S, 5C, 6 or 6+) With iOS 8 or later

For MFi Licensees under NDA only

# Digital Cluster

- Virtual cluster demo is built on top of the Linux fast boot demonstration published in the IMX Community.

- The boot time is roughly 1.5s.The demonstration is based on L3.0.101_4.1.1 BSP release running on i.MX6QSDP board.

# ADVANCED DRIVER ASSISTANCE SYSTEMS

# SURROUND VIEW

# i.MX 6 ADAS/Surround View Solution Overview

| Solution | Resolution | Part # | Feature |
|----------|-----------|--------|---------|
| CVBS | D1 resolution ADAS | Intersil TW6865 | CVBS -> PCIe |
| CVBS | D1 resolution ADAS | Intersil TW9985 | CVBS -> MIPI CSI |
| LVDS | HD Digital (720p) ADAS | Maxim MAX9271+MAX9286 | Camera->MAX9271(Coax) ->MAX9286(MIPI-CSI) |
| Ethernet | HD Digital (720p) ADAS | MPC5604+Ethernet Switch | Camera->MPC5604 -> Ethernet Switch |

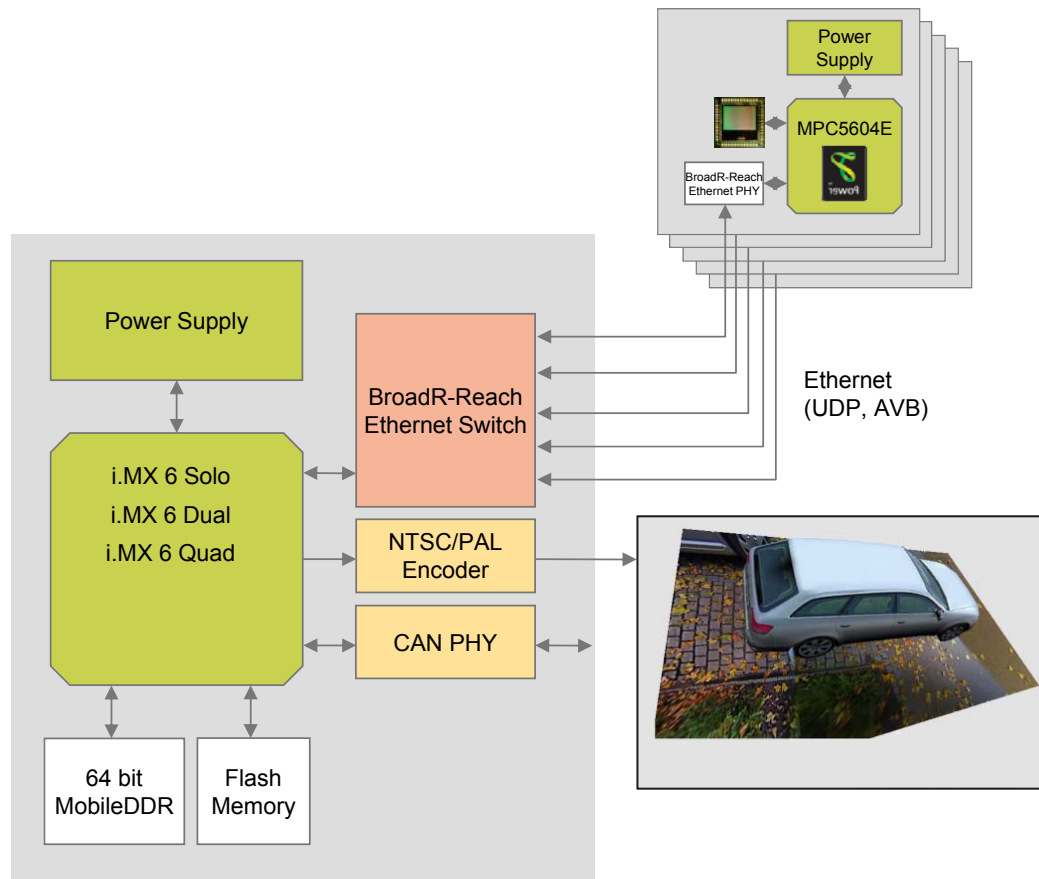# LVDS Surround View – Digital HD 720P
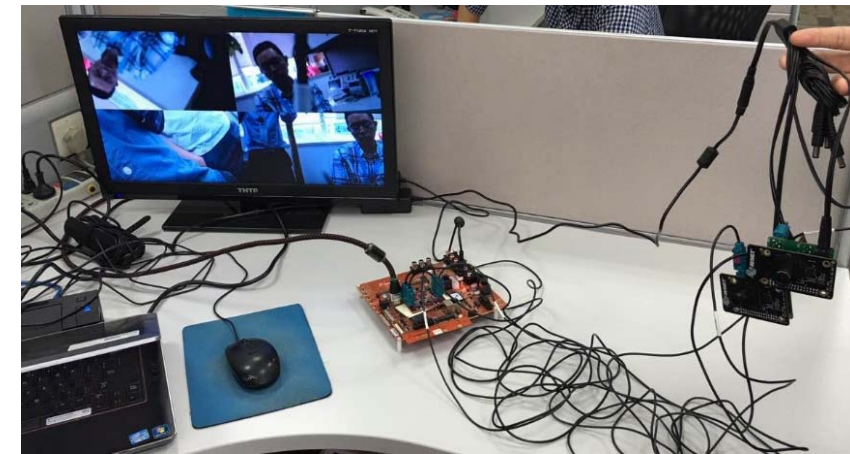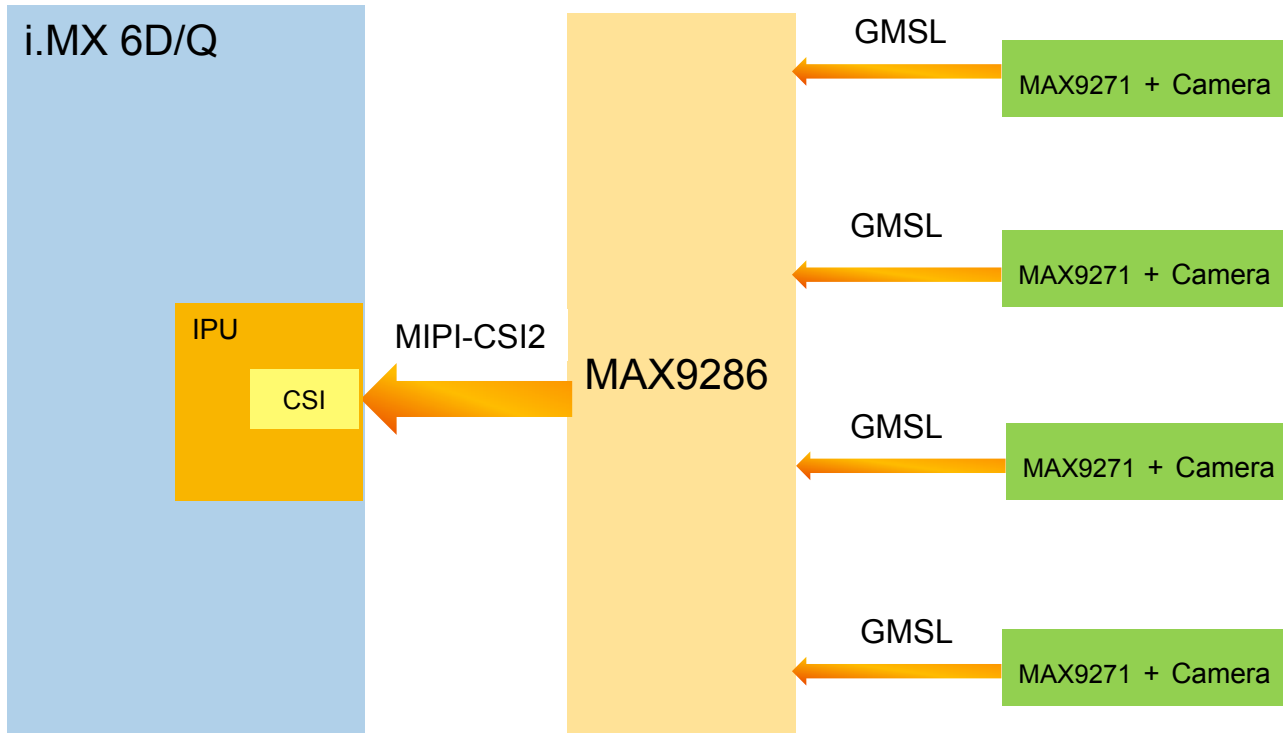
# Ethernet Surround View – Digital HD 720P



MPC5604E + Ethernet
Camera SW application

# Ethernet Surround View – UDP & AVB



Required:
- iMX6DQ platform
- Broadcom switch
- MPC5604E MCU
- OV camera sensor

* AVB is provided by software service

# Summary

1. Why NXP i.MX?

2. Not only key features enabled for automotive. And also, targeting on e-book, e-POS, IoT and so on…

3. Brings a wide range of components to today's designs.

Sensor (G-sensor, e-Compass, Gyro, TPMS…), PMIC, NFC, Wireless charger, MCU

# NXP

## SECURE CONNECTIONS
## FOR A SMARTER WORLD