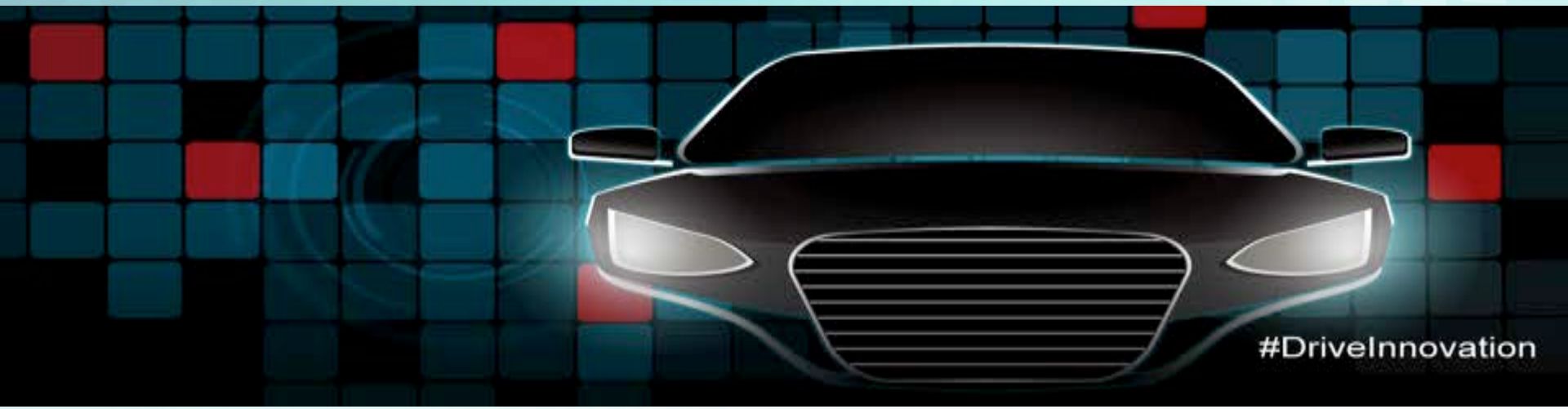
REVOLUTIONIZE THE AUTOMOTIVE COCKPIT



Texas Instrument – April 2017

SIGNIFICANT TRENDS IN AUTOMOTIVE …

GREENER

Fuel econmomy
electrification
hybridization…

SAFER

L1 & L2 ADAS,
automation…

CONNECTED

Integrated cockpit,
sensors, V2X…

FOUNDATIONAL SHIFTS IN THE AUTOMOTIVE INDUSTRY

6.5M
LINES OF CODE

Boeing 787
Dreamliner

100M
LINES OF CODE

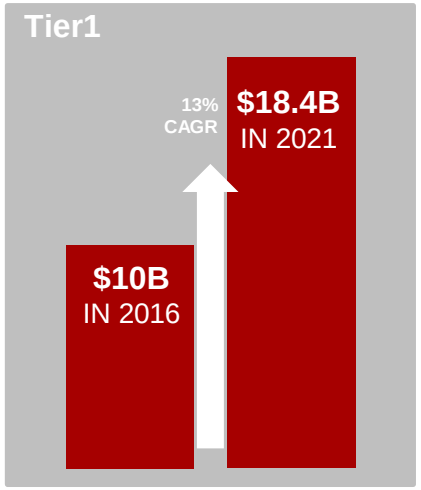
Average Luxury
Vehicle

Sources: IEEE, Automotive Designline

Vehicle hardware as differentiating factor	➔ Software
Long development cycles	➔ Shorten cycles
Human operated, stand-alone	➔ Assisted & connected
OEM at the center of high tech components	➔ Gravity shifting to electronics

… WITH DIGITAL COCKPIT REPRESENTING HUGE OPPORTUNITY

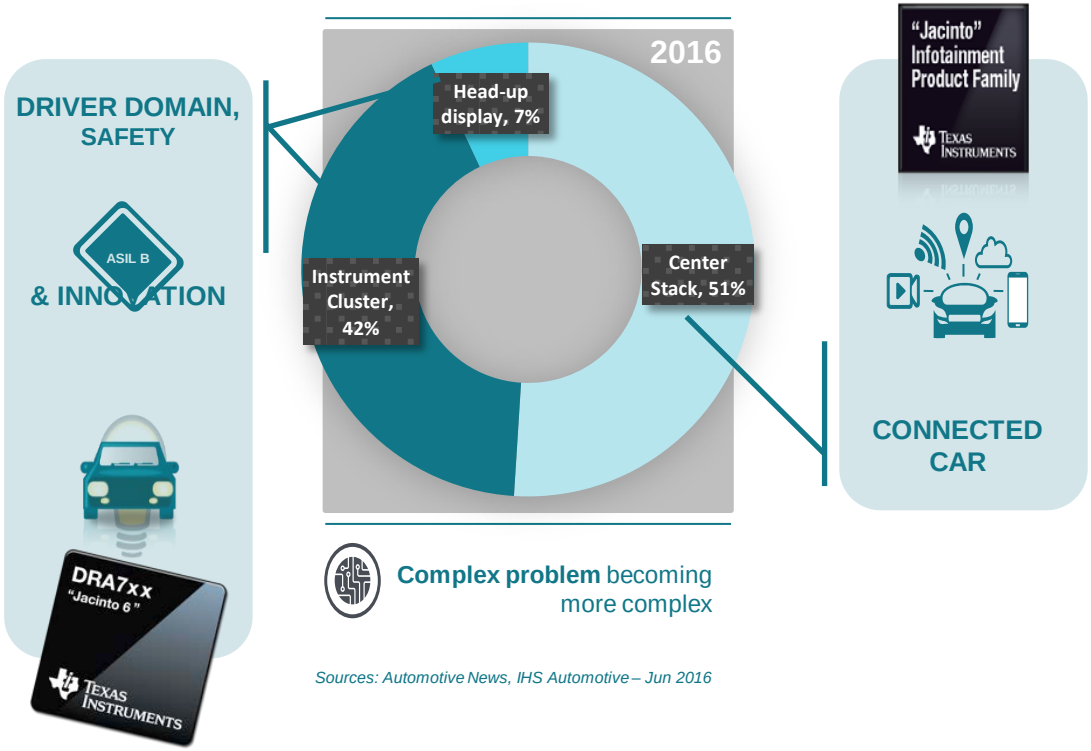
COCKPIT DISPLAY REVENUE



Steady growth in Automotive semiconductor content

Sources: Automotive News, IHS Automotive – Jun 2016

MARKET SHARE/SEGMENT



Complex problem becoming more complex

Sources: Automotive News, IHS Automotive – Jun 2016

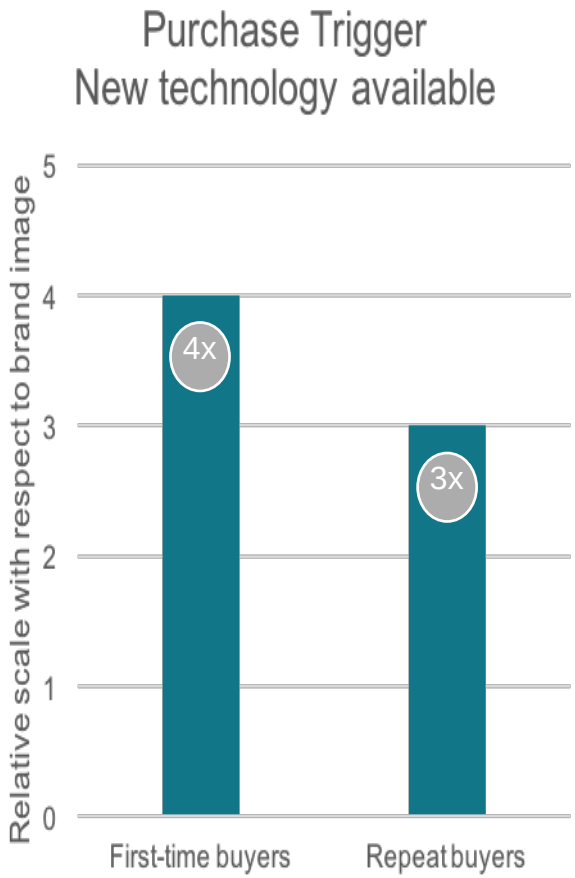
ELECTRONIC CONTROL UNIT (ECU)

- Automotive Processors are fundamental enabler for smarter, safer and connected vehicles
- ECU integration **mandatory** to meet features at cost point of future Digital Cockpit

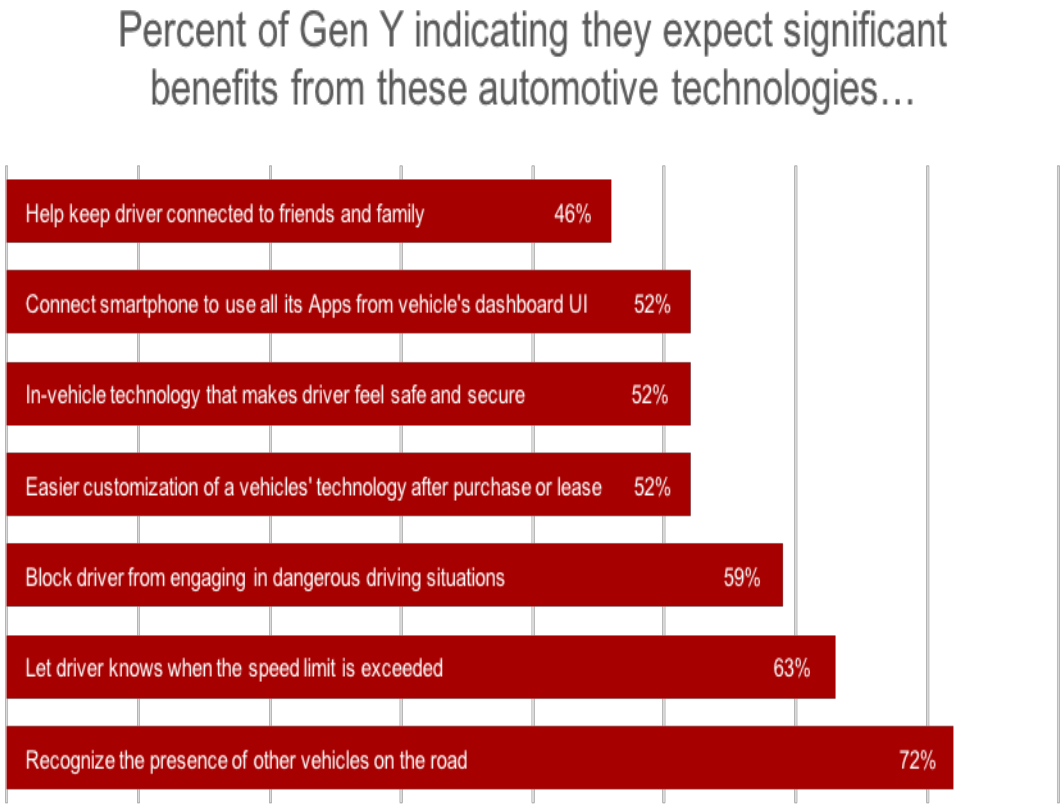
REVOLUTIONIZE DIGITAL COCKPIT

- Instruments panels : hybrid & digital reconfigurable clusters with more complex content
- Bigger displays, new ergonomics, augmented reality HUD, connected cars and more …

PURCHASE TRIGGERS FOR VEHICULE ARE EVOLVING …



Source: Deloitte. Driving through the consumer's mind – Dec 2014



Source: Deloitte 2014 Global Automotive Consumer Study

New technology available is up to 4x more important as a trigger than better brand image

… With new technologies at affordable cost. They aren't willing to pay much with only 27% willing to pay over $2,500

… AND REFLECTED IN TECHNOLOGY DEPLOYMENT

ECUs/car

40-50 IN 2005 → 80-100 IN 2015

Complex problem becoming more complex

Sources WindRiver, newelectronics

AVERAGE/car

$334 IN 2014 → $362 IN 2018

Steady growth in Automotive semiconductor content

Source: Gartner IHS, Bank of America Merrill Lynch

6.5M LINES OF CODE

Boeing 787 Dreamliner

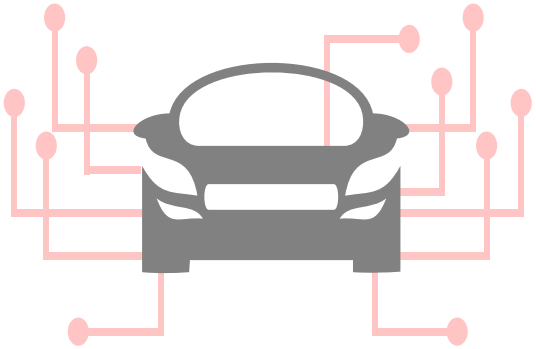
100M LINES OF CODE

Average Luxury Vehicle

Sources: IEEE, Automotive Designline

Semiconductor technology in general and Automotive Processors in particular have become a fundamental enabler for smarter, safer and connected vehicles

The "basic package" is expanding



WHAT DOES IT MEAN FOR AUTOMOTIVE PROCESSORS ?

End-user wants

- New technologies at affordable cost
- Optimize total cost of ownership
- Richer features than previous car
- Safer driving experience

Car OEM focus on

Benefit from technology improvements

Optimized ECU system cost

R&D efficiency

Automotive quality

Electronic systems reliability

Personalize HD virtual dashboard

- Digital cluster
- Dedicated audio zones
- Customize cockpit

Provide greater user's experience

- More HD displays
- Driver identification
- Cloud based services
- Cockpit noise reduction
- Natural voice recognition

Augment road perception

- 360 View, Robust RVC
- Augmented reality (AR)
- Head-up display (HUD)

Enhanced perception inside the car

- Driver monitoring
- Gesture control

Auto Processor

Optimized eBOM via integration and SW platforming

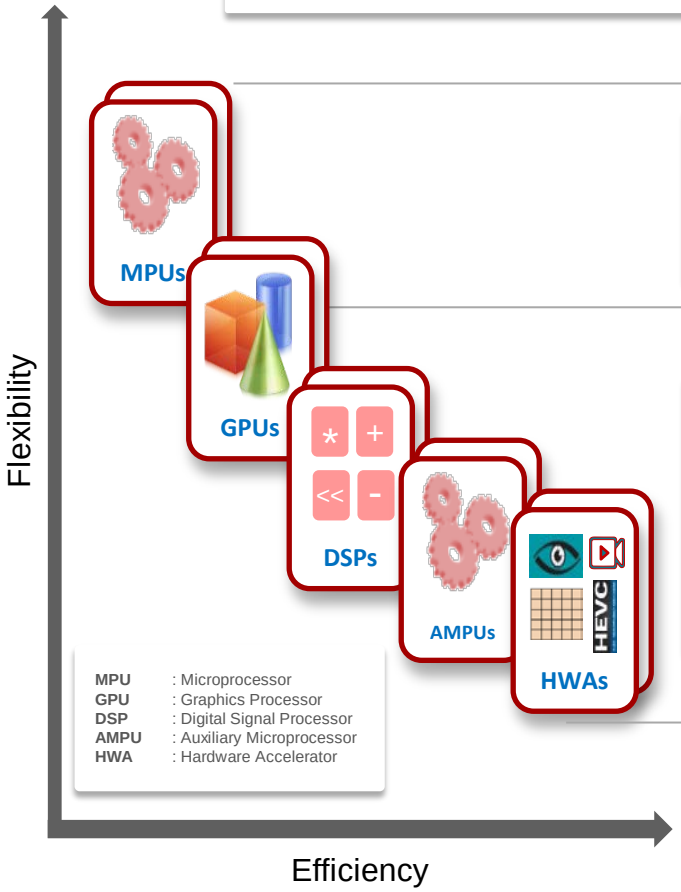
Heterogeneous architecture for best concurrencies: safety, security and performance

Differentiate via image, signal & vision processing capabilities

JACINTO HETEROGENOUS ARCHITECTURE

ONE SIZE DOESN'T FIT ALL

Choose the right core for the right job



MPU : Microprocessor
GPU : Graphics Processor
DSP : Digital Signal Processor
AMPU : Auxiliary Microprocessor
HWA : Hardware Accelerator

Optimize entire platform around programmer productivity on the MPUs

Offload the majority of "work" to specialized processors. Provide tools & SW to manage complexity

- Single to multi-cores MPU enable performance scalability and concurrencies
- Separate MPU clusters facilitates multi-OS and multi-domain software architecture
- Greater power efficiency than solution using general-purpose processors
- Auxiliary MPUs support real-time, safety OS and/or interrupt-intensive tasks
- Image, signal and vision co-processors for simultaneous IVI and InfoADAS features

JACINTO PROCESSORS INTEGRATION

DESIGNED FOR AUTOMOTIVE SAFETY & ROBUSTNESS

- High-performance graphics engine, can be virtualized using OpenGL ES client-server model
- Cluster QoS supported via prioritization of 3D processing thread at macro-tile boundary

- Optimize entire platform around programmer productivity on the MPUs
- High-level OS (HLOS), HMI
- HW virtualization support to run cluster processing functions in separate virtual machine (VM)
- Hypervisor

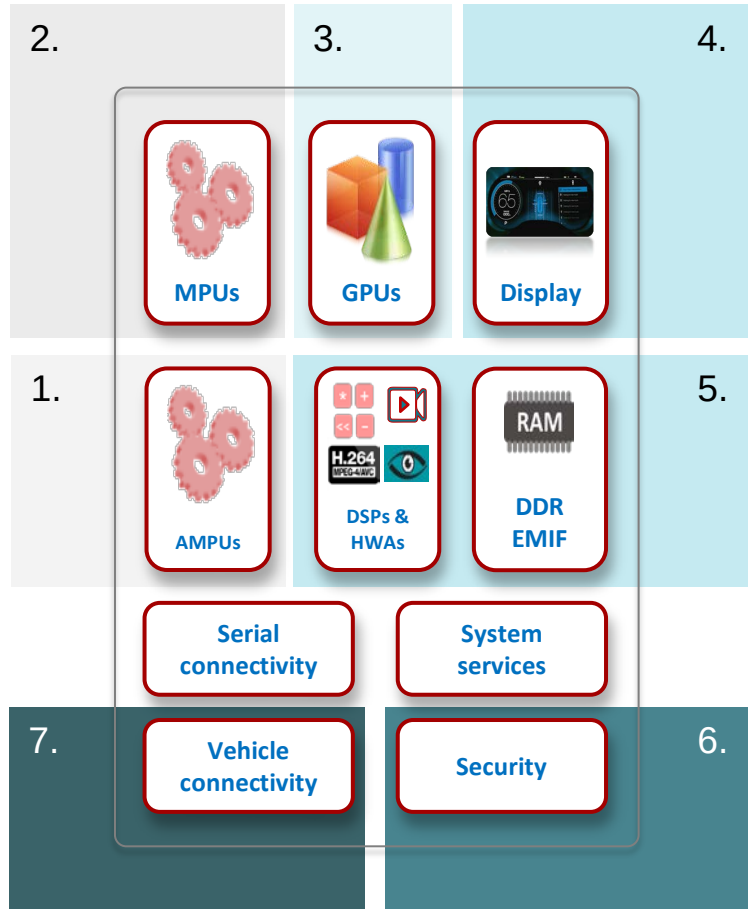
- Multi HD display
- Display write-back path

- Separation between HLOS & safety OS
- Robustness & safety features (frame-freeze, video watchdog, etc.)
- Offload interrupt heavy processing & Ctrl functionality (automotive stacks etc.)

- High memory bandwidth for best-in-class HMI, HD display support and improved auto concurrencies
- DDR Error Correction
- DSP cores and HW accelerators (HWA) for automotive differentiation / innovation

- Automotive peripherals
- Purpose-built automotive processors from inception to ensure auto certifications & the specific needs of car OEMs/Tier1s are met

- Numerous HW & SW security features provide Secure Boot & Trusted Execution Environment



JACINTO 6 FAMILY

SCALABLE AND SOFTWARE COMPATIBLE PROCESSORS FOR DIGITAL COCKPIT

	MPU	DSP & HWA	GPU	Multimedia	Display & Capture	Memory	Auto Peripherals
"Jacinto 6 Plus" DRA7xx	ARM A15 Dual Core MPU ARM M4, ARM M4 2x Dual Core Aux CPU	C66x DSP EVE ISP	3D GPU 2x SGX544 2D GPU GC320	IVA HD 1080p Video, VPE H.264 MPEG-4/AVC	Display Subsystem: 3 LCD, HDMI 1.4a Capture: 2x VIP, 2x CSI2	DDR3/3L 32b DDR3/3L 32b 512KB-2.5MB L3 RAM	CAN FD, DCAN PCIe eAVB
"Jacinto 6" DRA74x/75x	ARM A15 Dual Core MPU ARM M4, ARM M4 2x Dual Core Aux CPU	C66x DSP EVE	3D GPU 2x SGX544 2D GPU GC320	IVA HD 1080p Video, VPE H.264 MPEG-4/AVC	Display Subsystem: 3 LCD, HDMI 1.4a Capture: 2-3x VIP	DDR3/3L 32b DDR3/3L 32b 512KB-2.5MB L3 RAM	2x DCAN 2x PCIe eAVB
"Jacinto 6 Eco" DRA72x	ARM A15 Single Core MPU ARM M4, ARM M4 2x Dual Core Aux CPU	C66x DSP	3D GPU SGX544 2D GPU GC320	IVA HD 1080p Video, VPE H.264 MPEG-4/AVC	Display Subsystem: 2 LCD, HDMI 1.4a Capture: 1x VIP, 2x CSI2	DDR3/3L 32b 512KB L3 RAM	2x DCAN PCIe eAVB
"Jacinto 6 Entry" DRA71x	ARM A15 Single Core MPU ARM M4, ARM M4 2x Dual Core Aux CPU	C66x DSP	3D GPU SGX544 2D GPU GC320	IVA HD 1080p Video, VPE H.264 MPEG-4/AVC	Display Subsystem: 1 LCD, HDMI 1.4a Capture: 1x VIP, 1x CSI2	DDR3/3L 32b 512KB L3 RAM	2x DCAN PCIe eAVB

INNOVATE BEYOND INFOTAINMENT

DIFFERENTIATE VIA IMAGE, SIGNAL AND VISION PROCESSING

MODERN AUTOMOTIVE COCKPIT

1. IVI options available with high volume deployment of color display systems

1. Increasing deployment of cameras and sensors in the vehicle to support advanced safety capability (ADAS)

Leverage sensors both inside & outside the vehicle with IVI system to **AUGMENT** existing infotainment products with informational ADAS features[1]

INFORMATIONAL ADAS : Enhance the driver's experience

… vehicle setup automatically your digital cockpit preferences

… personalizing your HD virtual dashboard

… monitoring every angle of your vehicle at all time

… keep your eyes on the road while augmenting your perception

… enhancing your 3D navigation with head up display augmented reality

(1) : No active role in the control of the car (i.e. non-safety critical)

INFOTAINMENT TO INTEGRATED DIGITAL COCKPIT

Traditional instrument cluster & center-stack give :

- reliable vehicle and safety information
- access to favorite media content and more

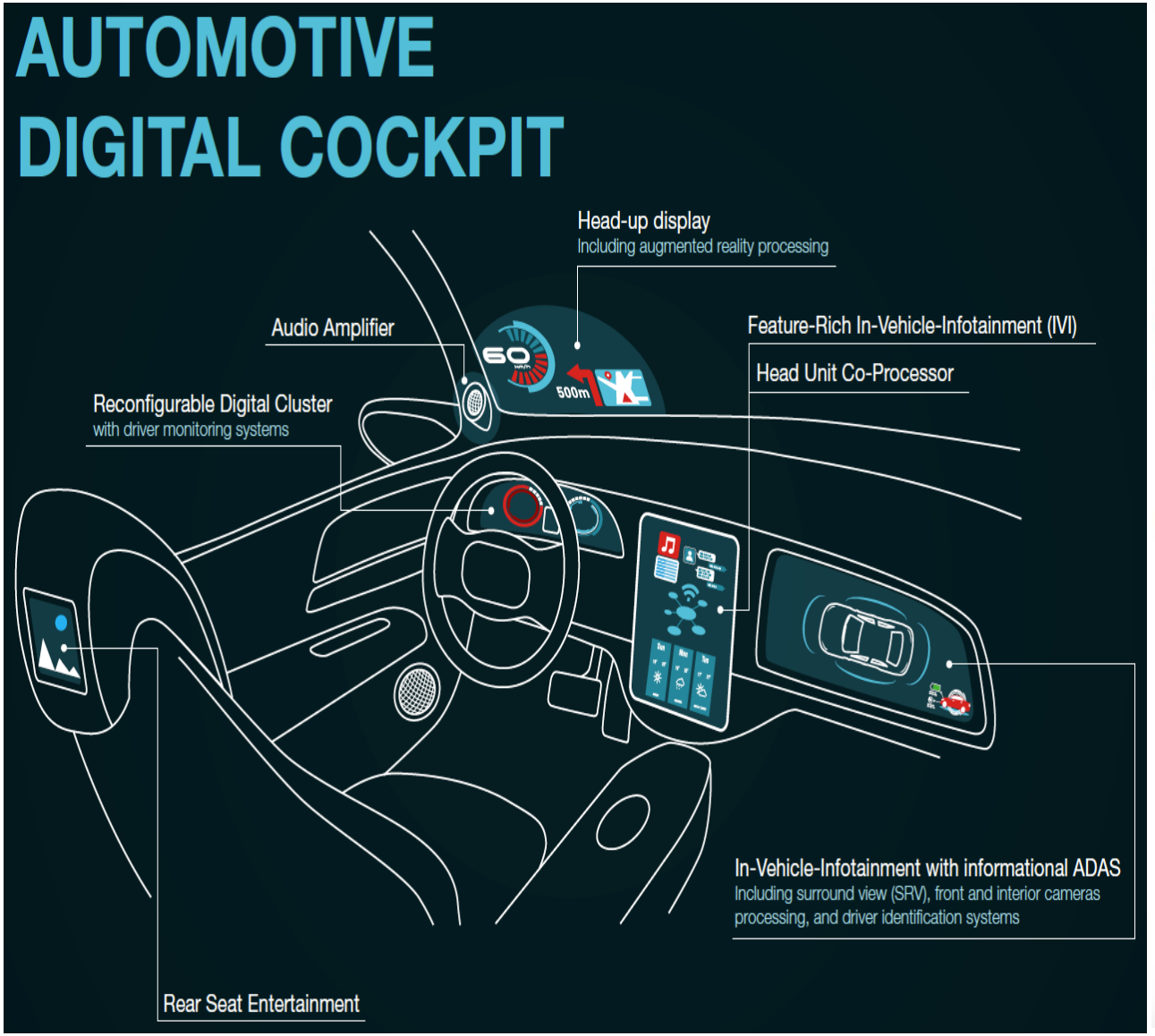
More complex content to be seamlessly blended in full HD, including endless media selections from any source, 3D navigation, ADAS and augmented reality views with the ability to morph size, shape and colors according to the task at hand and driving priorities

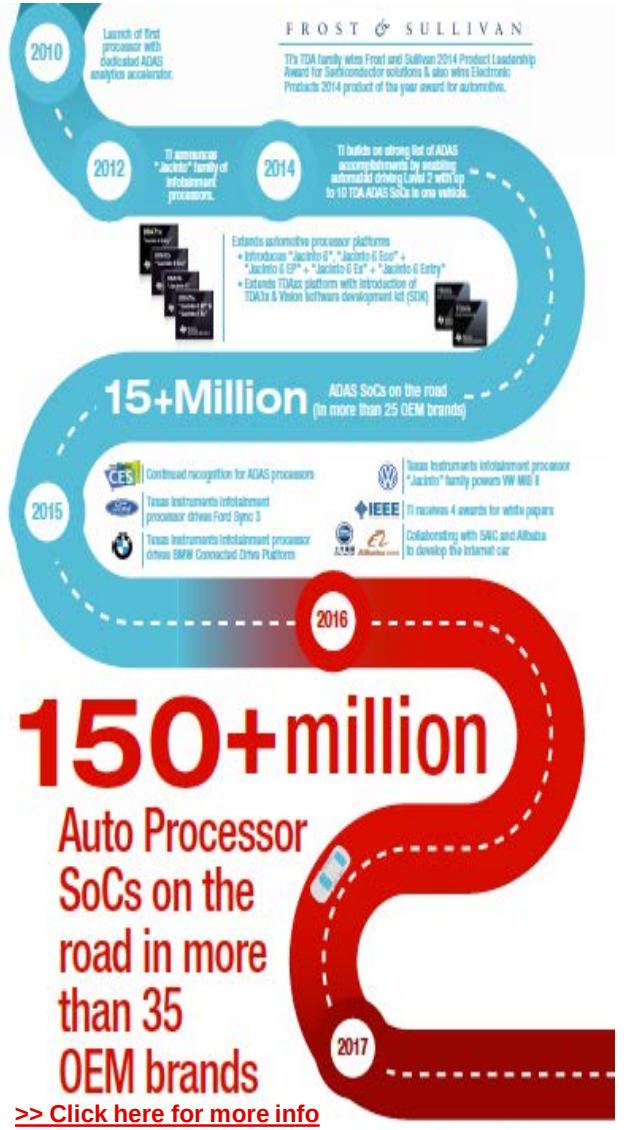
New ergonomics made possible to further improve their focus and attention on the road, including augmentation with Head-Up Display (HUD) to show relevant driving information in the driver's direct field of vision

Ultimately, display in the center field of vision relevant information and safety contents according to current driving situation which will pave the way to autonomous driving

INFOTAINMENT → **INTEGRATED DIGITAL COCKPIT**

JACINTO AUTOMOTIVE PROCESSORS





>> Click here for more info

Texas Instruments strong history with signal processing has produced strong results in the automotive industry, and will continue to enable the leading integrated digital cockpit and autonomous driving solutions of the future.

YouTube video - Click Here
Jacinto “wall” / scalability – Click Here

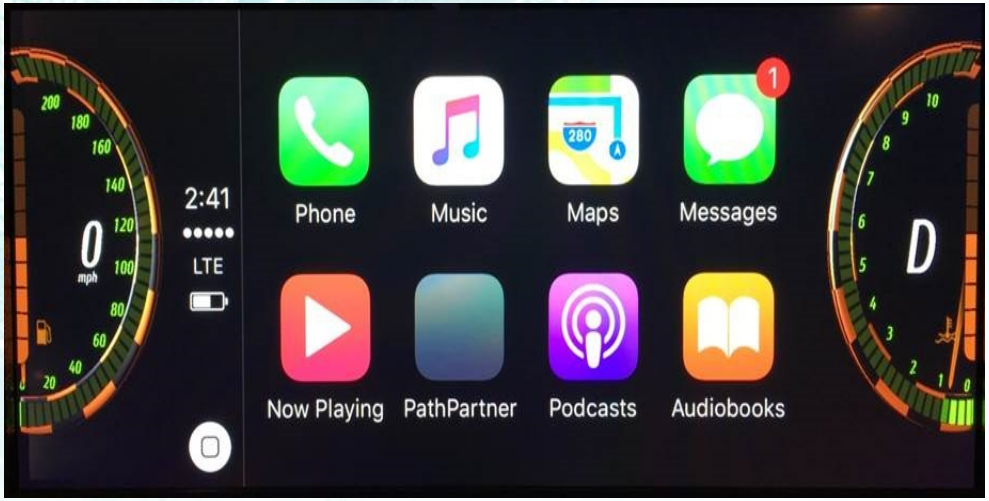
Your Source for Inspiration

“JACINTO 6 ENTRY” DIGITAL CLUSTER + DISPLAY AUDIO

FEATURE-RICH, SINGLE DISPLAY FOR THE ENTRY SEGMENT

WiFi Smartphone Screen Replication

Latest Digital Radio and Audio Features



Fast Boot by Texas Instruments

AGL Platform

“Jacinto 6 Entry” DRA71x

Digital Cluster and Display Audio on Single 1920x720 Display

PATHPARTNER

socionext for better quality of experience

CGISTUDIO

AUTOMOTIVE GRADE LINUX

Texas Instruments

YouTube video - Click Here
Rightware HMI on Jacinto 6 SoCs – Click Here

Your Source for Inspiration

"JACINTO 6 ENTRY" DIGITAL CLUSTER

ASIL-B CERTIFIABLE DIGITAL CLUSTER AT A LOW COST

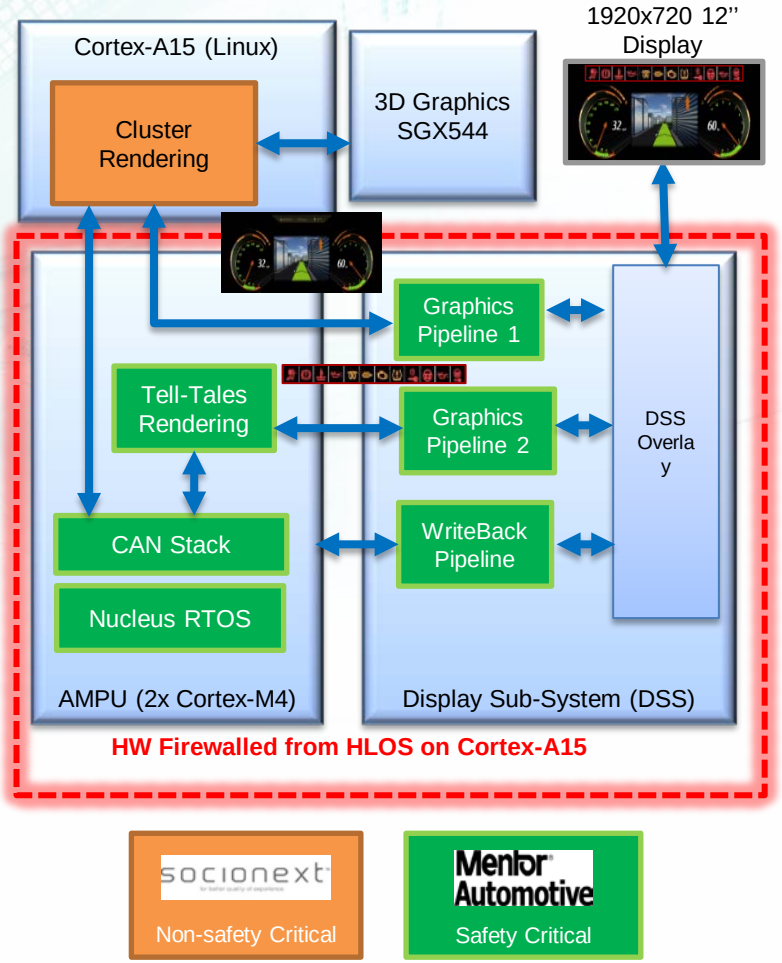
1920x720 at 60fps
- Performance at entry segment cost

Fast Boot Features

CAN stack on ARM Cortex M4

ASIL-B Certifiable
- Mentor Nucleus ® RTOS on ARM Cortex-M4
- Mentor Connected OS™ (Linux)

"Jacinto 6 Entry" DRA71x



socionext for better quality of experience
CGISTUDIO
Mentor Automotive

Texas Instruments

YouTube video - Click Here

Your Source for Inspiration

"JACINTO 6 PLUS" DIGITAL COCKPIT

PERFORMANCE AND INTEGRATION DRIVEN BY A SINGLE SOC

Fully Reconfigurable Digital Cluster
- Linux-based
- 1920x720 @ 60fps

ASIL-B Certifiable
- Optional ARM Cortex-M4 based Safety RTOS

Single "Jacinto 6 Plus" Processor
Multi OS/Hypervisor

1080p 15.6" Infotainment
- Android N OS
- Latest Digital Radio and Audio features

Hypervisor with GPU Sharing

Surround View Based on DSP + ISP

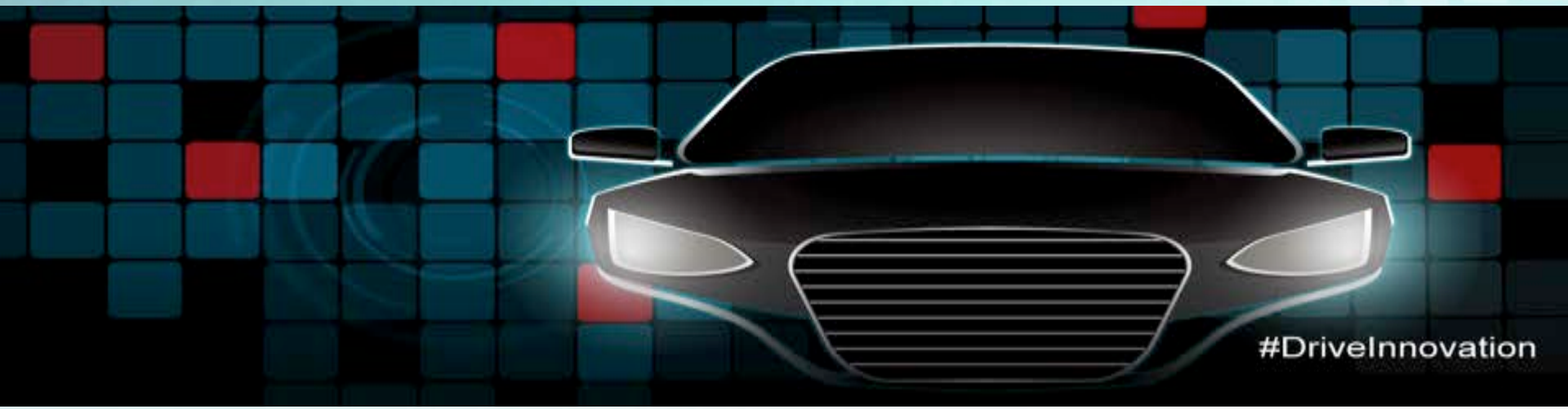
socionext for better quality of experience

CGISTUDIO

GlobalLogic

Texas Instruments

Enabling ADAS to Autonomous Driving



Texas Instrument – April 2017

Levels of Autonomous Driving

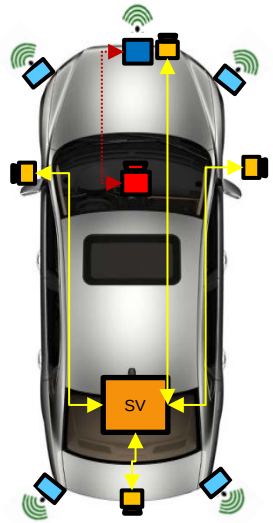
2014: Level 2 enabled by TI ADAS SoCs. In one vehicle there are up to 10 TI ADAS SoCs, in front camera, multiple radar, fusion, night vision, rear camera and 360 surround view cameras.

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

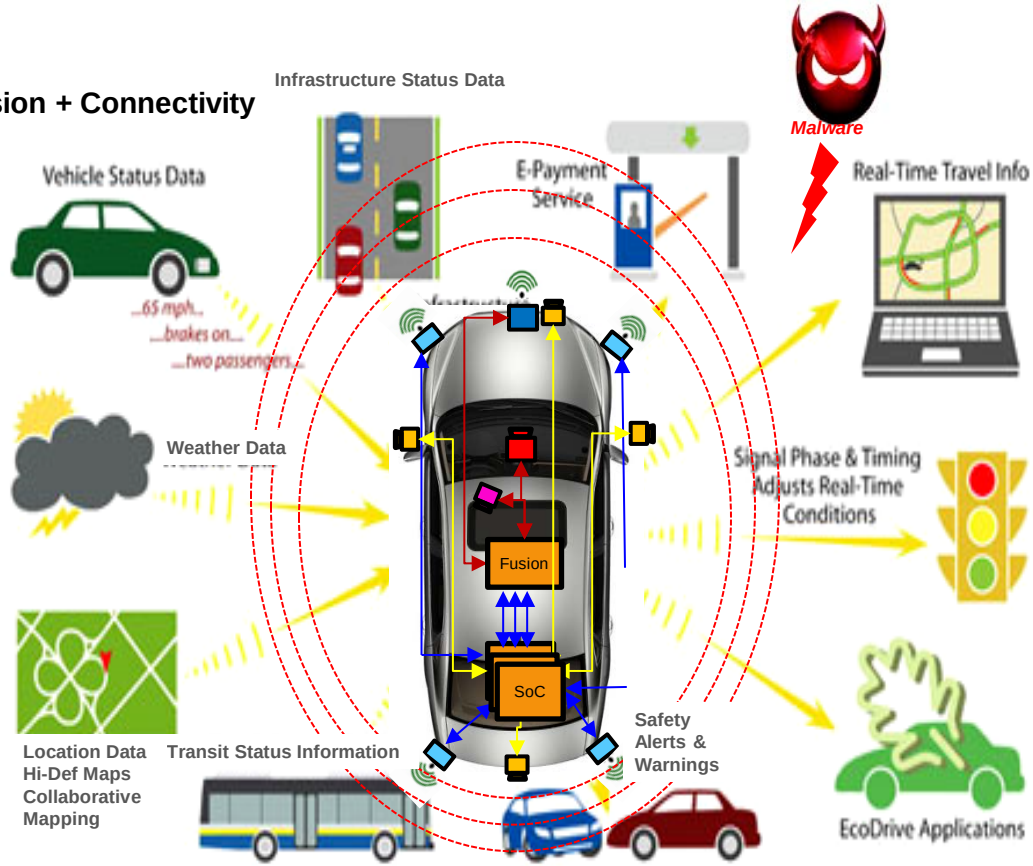
ADAS to Autonomous

Few sensors

More sensors



Fusion + Connectivity



ADAS – Driver Assist to Limited Driver Substitution

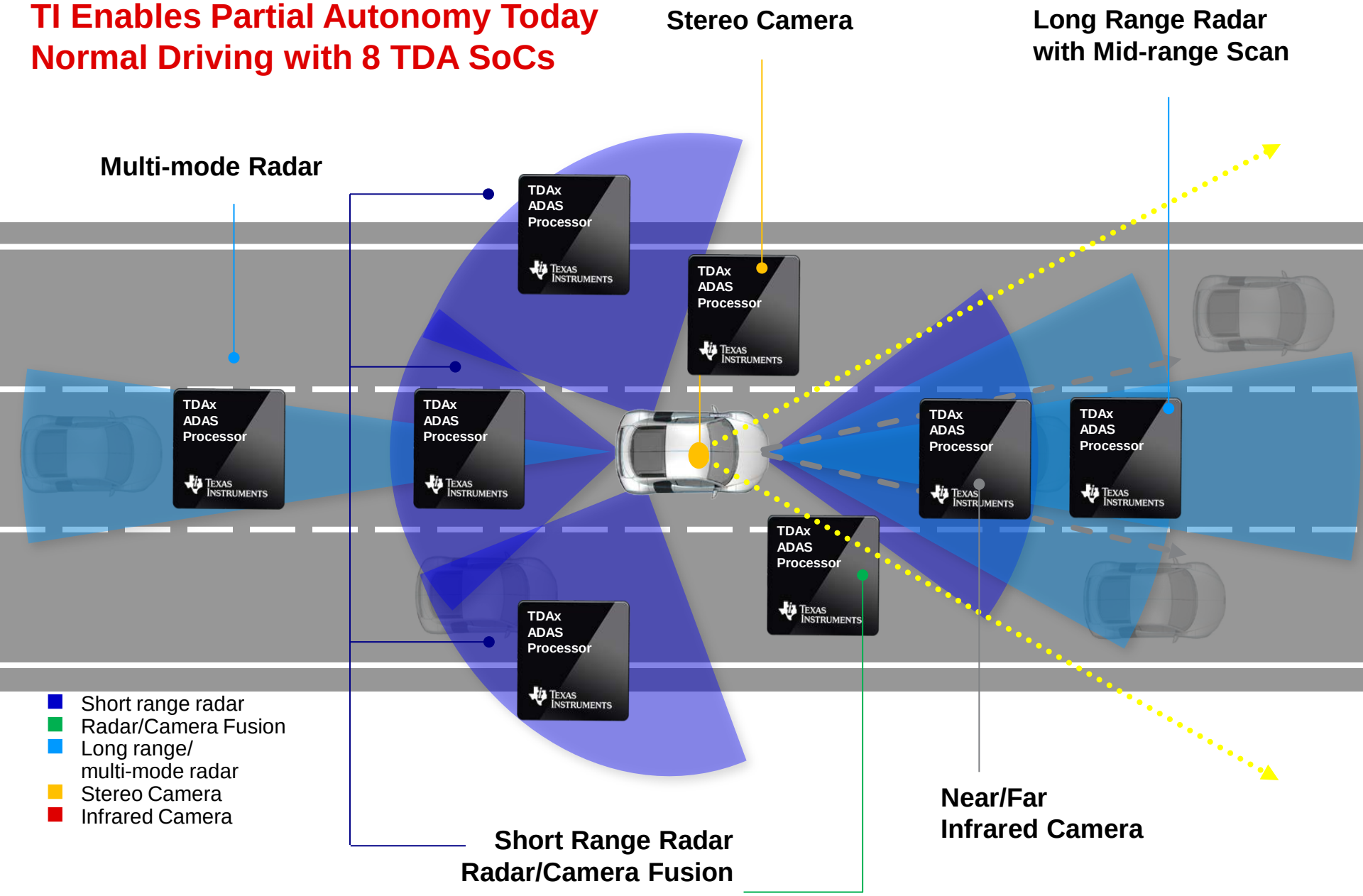
- Discrete signal processing with 1-4 sensors per SoC and limited fusion on big ARM SoCs
- Traditional Detection and Classification moving to Deep Learning
- Isolated compute provides security

Autonomous driving through connected/collaborative technology

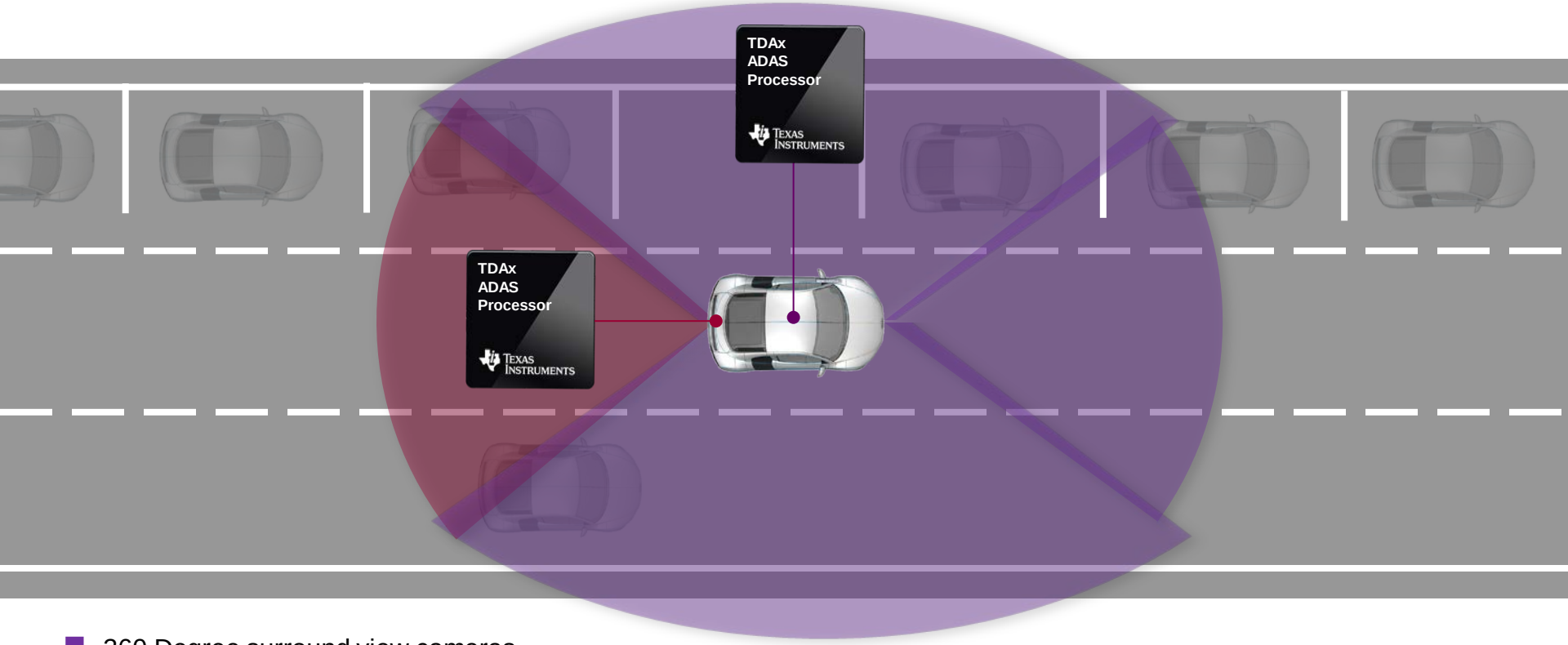
- Shift towards centralized signal processing
- Multi-Modal Sensor Fusion provides Robustness and Redundancy
- Heavy use of Deep Learning
- Connected compute needs active security

ADAS → **Autonomous Driving**

TI Enables Partial Autonomy Today
Normal Driving with 8 TDA SoCs

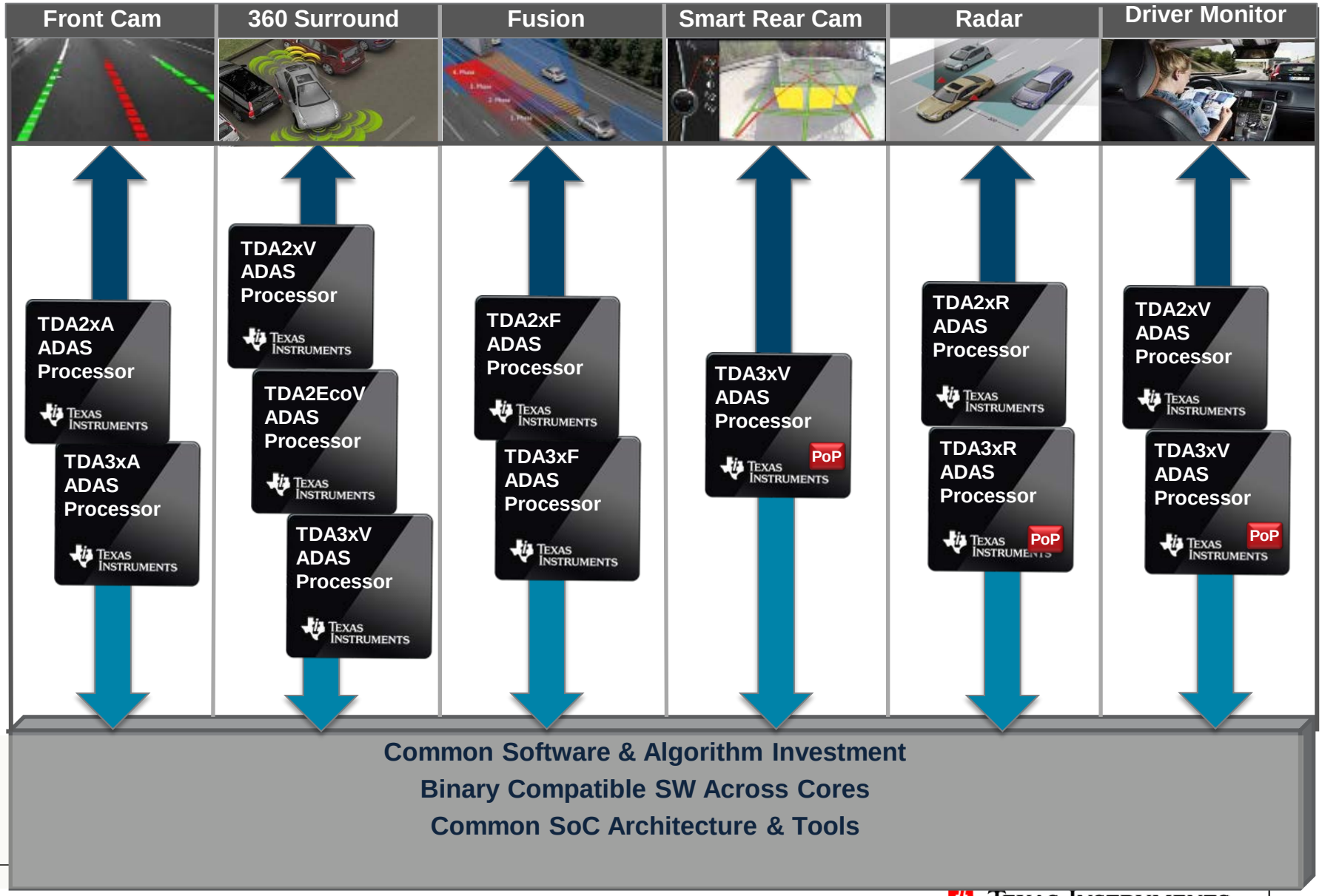


Additional 2 SoCs for Park Assist, equals 10 TI ADAS SoCs in one car!

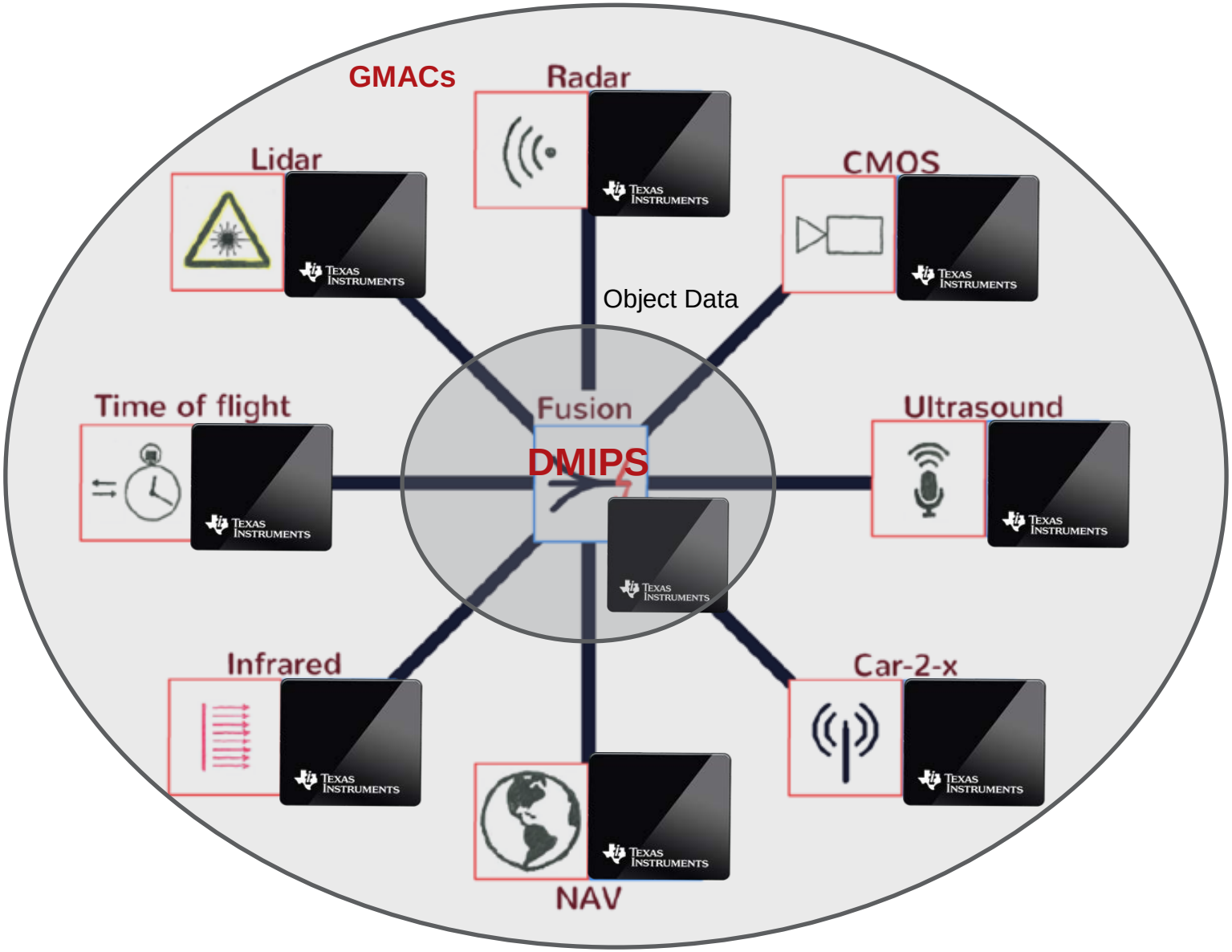


- 360 Degree surround view cameras
- Smart rear view camera

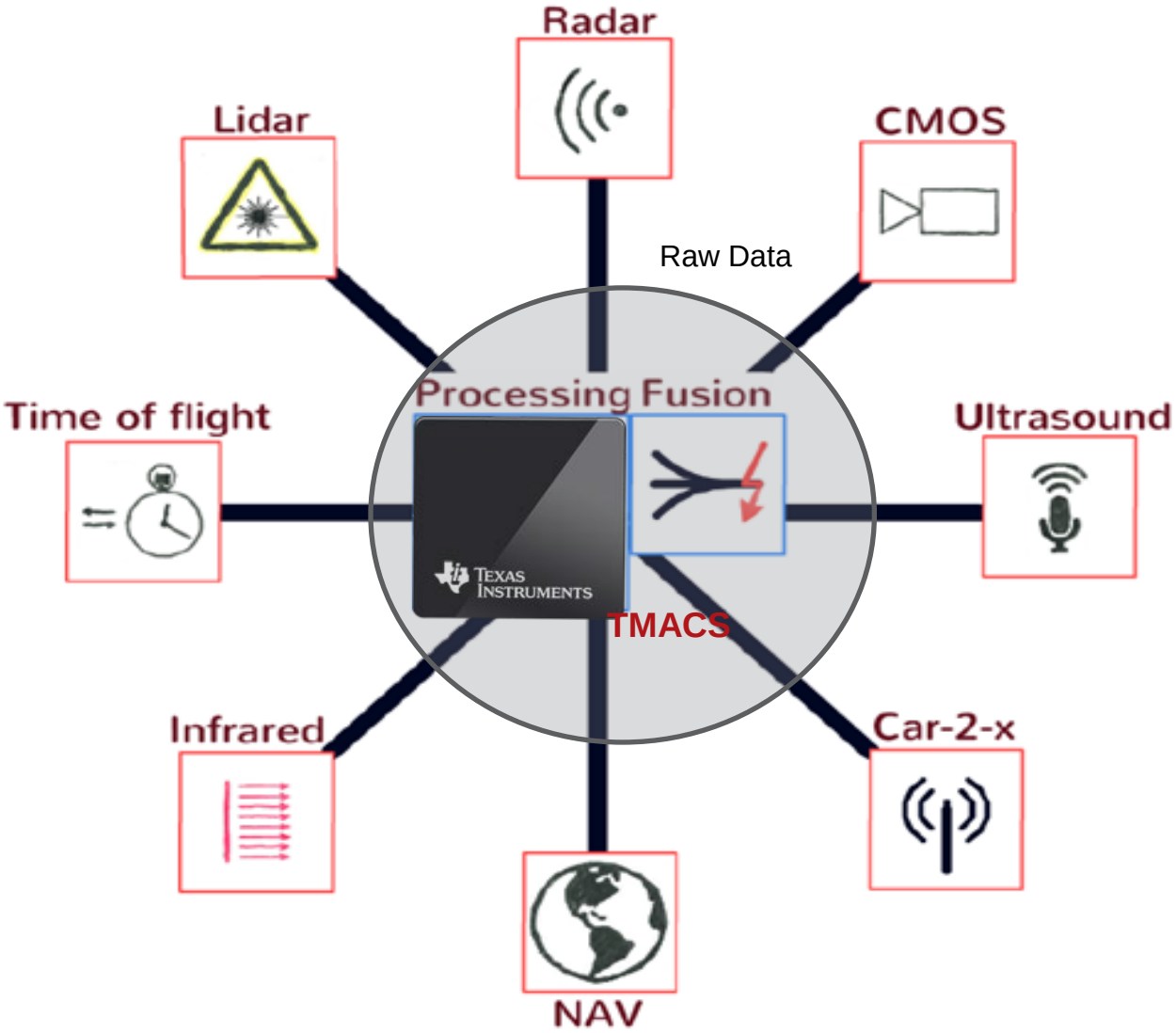
TDA Family HW & SW Scalability



Distributed Processing using Common Architecture - Near Term

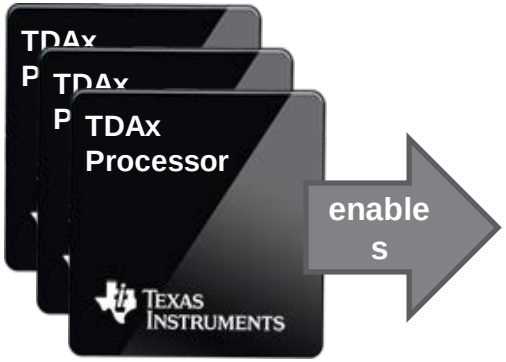


Centralized Processing on Common Architecture - in the Future



TI is focused on providing world class signal processing to enable ADAS today and Autonomous Driving tomorrow

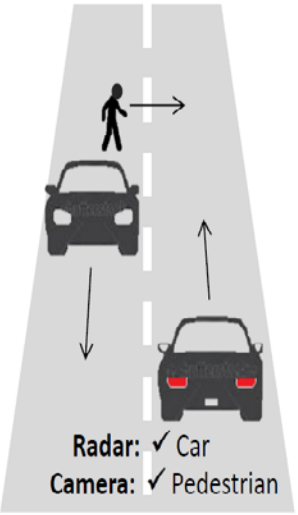
TDAx SoC Family Demos at CES 2017



- Industry-leading, integrated ISP
- Best-in-class flicker mitigation
- 3D surround view plus bonus view(s) without GPU
- Live, full-size vehicle demonstration
- Rear stitch view panorama

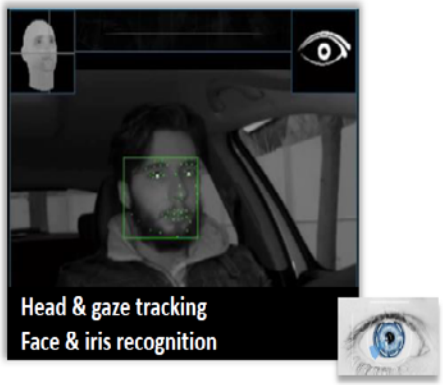
Augmented Around Viewing

Increased Safety via Increased Visibility



ADAS Fusion for Safety

LED Flicker Mitigation

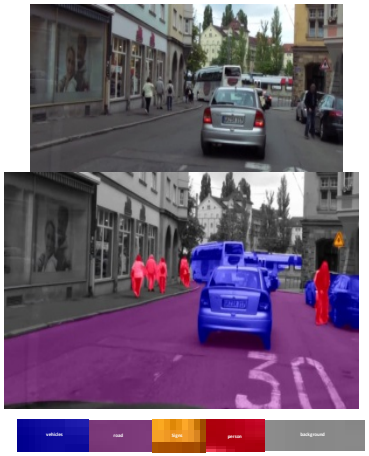


Advanced Driver Monitoring

From Fotonation

Front Camera NCAP Solutions

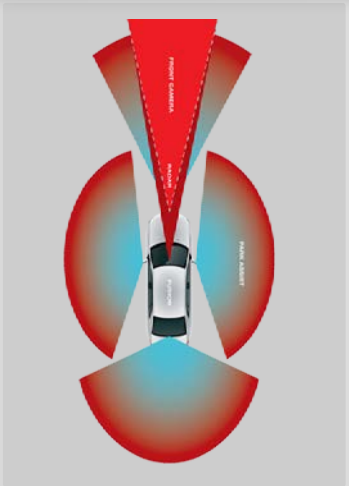
From KPIT & Hella Aglaia



Deep Learning

Semantic Segmentation

Innovation across 5 key market sectors

Advanced driver assistance systems	Passive safety	Hybrid/electric and powertrain systems	Body electronics & lighting	Infotainment & cluster
				
Adaptive cruise control Night vision Blindspot detection Lane departure warning	Automatic braking Airbag deployment Antilock braking Tire pressure monitoring	Automatic start/stop Battery management Electric power steering Engine and transmission control	Security system Seat position control Remote keyless entry Lighting	Entertainment system Head-up display Navigation system eCall

and more…

Why TI for automotive?

Portfolio

- Broad and deep portfolio, **2,000+ AEC-Q100 qualified parts**
- **250+** reference designs plus tools, software
- TI.com is one-stop shop

TIDesigns

Innovation

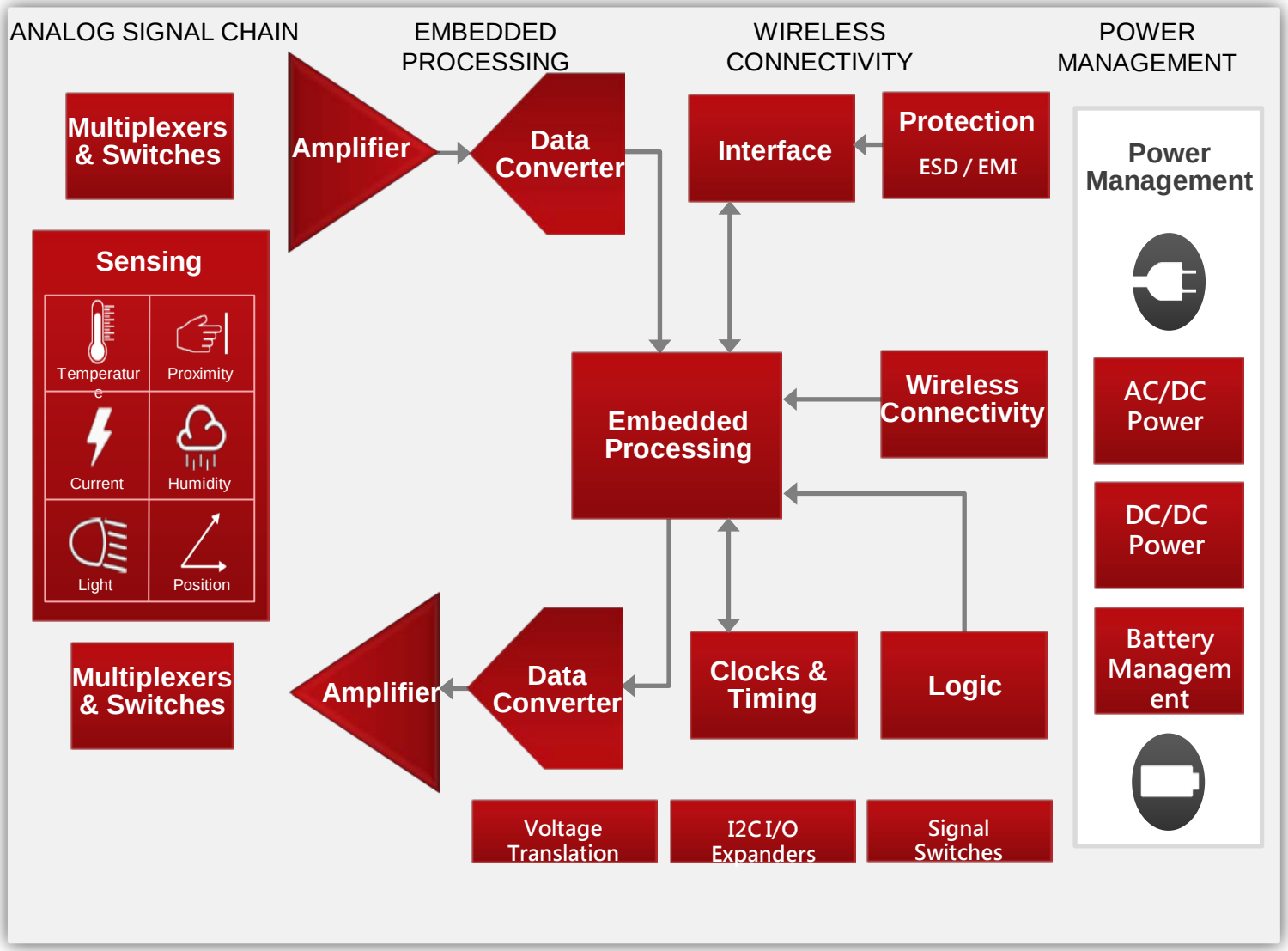
- **50+** product lines innovating for automotive
- Process and packaging technology
- Kilby Labs researching new technologies

Commitment

- Quality, reliability, safety → **SafeTI™** design components and packages
- Local support, TI E2E™ Community
- Sales coverage expanded
- **30+** years of experience

Leading analog and embedded products for automotive

Applications



Technology

Thank You