TI Jacinto Solution for Digital Cockpit, Cluster and ADAS

Texas Instrument
Infotainment and ADAS Trend

Automotive SoCs

TDAx

DRAx

Scalable SW & Tools
Safety & Security

Radar/Lidar
Low cost
Scalable
Flexible

Front Cam
Low Power
Scalable
Deep Learning

Fusion
Performance
Scalable
Safety

CMS
Low Power
Scalable
ISP + LFM

Smart Rear Cam
Low Power
Low Cost
ISP

Around View
Low Cost
Scalable
Analytics

DMS
Low Power
Scalable
Analytics

Cockpit
Graphics/multimedia
Safety Integration
Scalability

Center stack
Graphics/multimedia
Safety Integration
Scalability

Cluster
Graphics performance
Robustness
Vehicle connectivity

Rear Seat
Graphics/multimedia
Re-Use

Silverbox
Antenna & Amplifier
Modules
Scalability

Gateway/Vehicle
Computer
Ethernet Bandwidth
Security/Safety
Vehicle connectivity

V2V/V2X
Security
Integration
Vehicle connectivity

Low Cost
Scalable
ISP + Analytics

Low Power
Scalable
ISP + Analytics

Low Power
Scalable
ISP + LFM

Low Power
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Low Power
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Texas Instruments

Texas Instruments
Infotainment and Automotive Cockpit

Texas Instrument

www.ti.com/infotainment
Jacinto SoC Family Demos

**Jacinto 6**
- Processor

**Jacinto 6 Entry**
- Processor

**Jacinto 6 Plus**
- Processor

**Jacinto 6 Plus Processor** enables

"JACINTO 6 PLUS" DIGITAL COCKPIT

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

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

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

Hypervisor with GPU Sharing

Surround View Based on DSP + ISP

Single "Jacinto 6 Plus" Processor
Multi OS/Hypervisor

"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)

WiFi Smartphone Screen Replication
- Latest Digital Radio and Audio Features

"JACINTO 6 ENTRY" DIGITAL CLUSTER + DISPLAY AUDIO

"Jacinto 6 Entry" DRA71x
- Digital Cluster and Display Audio on Single 1920x720 Display

Fast Boot by Texas Instruments
- AGL Platform

**PATHPARTNER**
JACINTO HETEROGENOUS ARCHITECTURE
ONE SIZE DOESN’T FIT ALL

Choose the right core for the right job

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

<table>
<thead>
<tr>
<th>MPU</th>
<th>MPU: Microprocessor</th>
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<tbody>
<tr>
<td>GPU</td>
<td>GPU: Graphics Processor</td>
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<tr>
<td>DSP</td>
<td>DSP: Digital Signal Processor</td>
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<tr>
<td>AMPU</td>
<td>AMPU: Auxiliary Microprocessor</td>
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<tr>
<td>HWA</td>
<td>HWA: Hardware Accelerator</td>
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## Jacinto 6 Family

### Scalable and Software Compatible Processors for Digital Cockpit

<table>
<thead>
<tr>
<th></th>
<th>MPU</th>
<th>DSP &amp; HWA</th>
<th>GPU</th>
<th>Multimedia</th>
<th>Display &amp; Capture</th>
<th>Memory</th>
<th>Auto Peripherals</th>
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<tr>
<td><strong>“Jacinto 6 Plus”</strong></td>
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<td>ARM A15</td>
<td>2x Dual Core Aux CPU</td>
<td>C66x DSP EVE</td>
<td>3D GPU 2x SGX544 2D GPU GC320</td>
<td>IVA HD 1080p Video, VPE</td>
<td>DDR3L 32b</td>
<td>CAN FD, DCAN</td>
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<td>Dual Core MPU</td>
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<td><strong>“Jacinto 6 Eco”</strong></td>
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**Texas Instruments**
Automotive Gateway Current Limitation

**GREENER**
Fuel economy electrification hybridization...

**CONNECTED**
Integrated cockpit, sensors, V2X...

**SAFER**
L1 & L2 ADAS, automation...

Car sharing, fleet management, smart phone access (authenticate...)
Security, safety

**LIMITATION**

**ECU Flashing:**
Data rate of traditional CAN bus (125/500Kbps) make ECU flashing a long process

**System Isolation:**
ECUs in vehicle are isolated due to lack of high bandwidth data channel and data sharing is difficult

**ECU Consolidation:**
Help to reduce system complexity, cost and weight but requires more information exchange / high bandwidth data communication technology

**Intelligent Car:**
more sensors deployed requires to connect different ECUs to realize coordination control and data sharing

MCUs can't scale. Need App Processor with desire to use proven network Arch/SW
Automotive Gateway Evolution

Central Gateway
Connected through Ethernet (TSN), CAN-FD, LIN, Flexray etc.

PLATING

Connectivity
Telematics

Body Electronics
- Power windows
- Power mirrors
- Air conditioning
- Central Locking
- ...

ADAS
- Sensors: camera, radar, lidar
- Processing
- Decisions
- ...

Cockpit
- Display: head-unit, HUD, RSE
- Radio, Nav.
- Rear View Camera
- ...

Powertrain
- Engine
- Battery
- ...

Chassis & Safety
- Steering
- Break
- Throttle
- ...

Wi-Fi
LTE

Central Gateway

Domain Controller
/Gateway
ECU

Domain Controller
/Gateway
ECU

Domain Controller
/Gateway
ECU

Domain Controller
/Gateway
ECU

Domain Controller
/Gateway
ECU

Domain Controller
/Gateway
ECU

AR9.3

64-bit ARMv8 MPUs

AR9.3

64-bit ARMv8 MPUs

AR9.3

64-bit ARMv8 MPUs

AR9.3

64-bit ARMv8 MPUs

Common high-performance chassis
Hi-performance SoC for next generation automotive platforms (Texas Instruments)
Advanced implementation suitable for high-performance & power-constrained scenarios

Safety
- System-level
- HW-SAAS

Security
- Source-code
- HW-TPM

Automotive connectivity
- cloud, 5G, LTE, Wi-Fi, Bluetooth

Memory System
L2C

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Texas Instruments
Enabling ADAS to Autonomous Driving

Texas Instrument

www.ti.com/adas
TDAx SoC Family Demos

- LED Flicker Mitigation
- 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

Advanced Driver Monitoring From Fotonation

Front Camera NCAP Solutions From KPIT & Hella Aglaia

ADAS Fusion for Safety

Deep Learning Semantic Segmentation
ADAS to Autonomous

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

Few sensors → More sensors

- Fusion + Connectivity
- Infrastructure Status Data
- Vehicle Status Data
- Location Data
- Hi-Def Maps
- Collaborative Mapping
- Weather Data
- Safety Alerts & Warnings
- E-Payment Service
- Real-Time Travel Info
- Signal Phase & Timing Adjusts Real-Time Conditions
- Hi-Def Def Maps
- Transit Status Information
- Malware
- EcoDrive Applications

Texas Instruments
TI Enables Partial Autonomy Today
Normal Driving with 8 TDA SoCs

- Short range radar
- Radar/Camera Fusion
- Long range/multi-mode radar
- Stereo Camera
- Infrared Camera

Stereo Camera
Long Range Radar with Mid-range Scan

Multi-mode Radar

Short Range Radar
Radar/Camera Fusion

Texas Instruments
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

Common Software & Algorithm Investment
Binary Compatible SW Across Cores
Common SoC Architecture & Tools
TI mmWave Radar Sensor

Texas Instrument

www.ti.com/mmwave
mmWave Sensing Applications

Automotive
- Highway Pilot
- Front NCAP applications
- Rear NCAP applications
- Body and Chassis sensors

Beyond Automotive
- Level Probing
- Building Automation
- Traffic Monitoring
- Factory Automation
- Precision Measurement
- Occupancy Sensing
- Perimeter Surveillance
- Drones
- Vibration Monitoring
- Gesture Recognition
- Vital Sign Monitoring
- Industrial Transport & Robots
Automotive Radar

- **Imaging Radar**: Detect objects at angular resolution < 1° for highway urban driving
- **Short Range Radar**: Smallest single chip radar sensor sending object data over CAN interface
- **Obstacle detection**: Detect obstacles around a car door and trunk using a free space sensor
- **Driver vital sign detection**: Capture the driver’s vital signs
- **Vehicle occupant detection**: Detect lifeform or passengers in a vehicle
- **Gesture recognition**: Trigger actions with simple gestures
- **Full experience**: Take a ride in a car fitted with TI mmWave radar sensors

1. **People Counting**
   a. Showcasing use of IWR1642 and onboard DSP for security/surveillance applications
   b. mmWave is non-invasive, technology for real-time counting and tracking of individuals
2. **Robot Sense / Avoid**
   a. IWR1443 as a point cloud sensor for sense and avoid robotics applications using ROS
   b. Detection of obstacles and automatic navigation around them
3. **Level Sensing**
   a. Showing mmWave for high-accuracy range measurement for fluid level sensing
   b. Water dispenser that can calculate volume dispensed from range measurement
4. **Gesture Recognition**
   a. Detection and classification of hand gestures using mmWave range, velocity, angle data
   b. ‘Swipe’ and ‘twirl’ gestures used to control video interface and mock medical interface

Industrial Radar
Single chip integration enabled by CMOS

Discrete Multi-Chip mmWave Sensor
- Discrete solution – expensive
- Complex and critical signal routes
- Unconventional packaging
- Prone to noise
- Lack of system level observability
- Crude implementation of RF and Baseband safety

TI Single-Chip mmWave Sensor
- Smaller in size
- Simpler design
- Built in monitoring and calibration (ASIL)
- High Resolution, less false positives
- Programmable core
- Lower Power
76 – 81 GHz mmWave Sensors

**AWR1243**
- **Radar Sensor**
  - **Use Cases**
    - Imaging Radar Sensor
      - 2x or 4x AWR12 (cascade) + External DSP
    - MRR and LRR
  - **ASIL-B**
  - **ES3.0 PPAP: June 2018**

**AWR1443**
- **Radar Sensor + HW Accelerator**
  - **Use Cases**
    - Entry-level Single-chip Radar
      - Proximity warning
    - Free space sensor in and around the vehicle
    - Occupant detection, driver monitoring
  - **ES3.0 PPAP: June 2018**

**AWR1642**
- **Radar Sensor + DSP**
  - **Use Cases**
    - USRR Single Chip Radar
      - 160 Degree, 40m
    - SRR Single chip Radar
      - 120m Cross traffic Alert
  - **ASIL-B**
  - **ES2.0 PPAP: Mar 2018**
Sensor configuration with TI mmWave solutions

**IMAGING**

- AWR1243
- Processor

**CORNER/MRR**

- AWR1243
- Processor
- AWR1243

**LRR**

- AWR1243

**SRR**

- AWR1642

**USRR**

- AWR1642

**Proximity**

- AWR1443

**Satellite Configuration**

- Processor
- AWR1243
- AWR1243
- FPD

**CANFD**

- Processor
- AWR1642
- AWR1642
- AWR1642
- AWR1642
Key market segments

Free Space Sensor
• Car/Door Openers
• Park Assistance
• Suspension control
• Detection of ice/water on road

Vehicle Occupant Detection
• Child Left behind
• Intrusion detection
• Occupant classification (adult or child) for air bag deployment

Driver Vital Sign Monitoring
• Driver/Passenger Heart rate
• Driver sleep state detection
• Passenger ill/pass out

Swipe/Kick to open
• Kick to open tailgate
• HMI screen change
• Knob control
• Panes open/close
Evaluation to Production

Evaluation
- MmWave SDK
- Sensing Estimator (Radar parameter design tool)
- White Paper, App note (Technology and Usage)

Prototype
- TI Rex (Code)
- Object/Gesture detection database
- 3rd Party modules/TI EVM

Production
- Antenna design house
- TurnKey solution
- Module/Software solutions