

恩智浦新一代毫米波 雷达芯片解析

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产品市场部, Radar&V2X
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SECURE CONNECTIONS
FOR A SMARTER WORLD

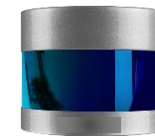
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Radar relevance in ADAS

	Camera	Radar	LiDAR
Object Detection	Low	High	Medium
Angular Resolution	High	Low	Medium
Range Estimation	Low	High	High
Velocity Estimation	Low	High	Low
Lane Detection	High	Low	Medium
Night Vision	Low	High	High
Sun Sensitivity	High	Low	Low
Weather Sensitivity	Medium	Low	High
Classification	High	Low	Medium
Cost	Low	Low	High

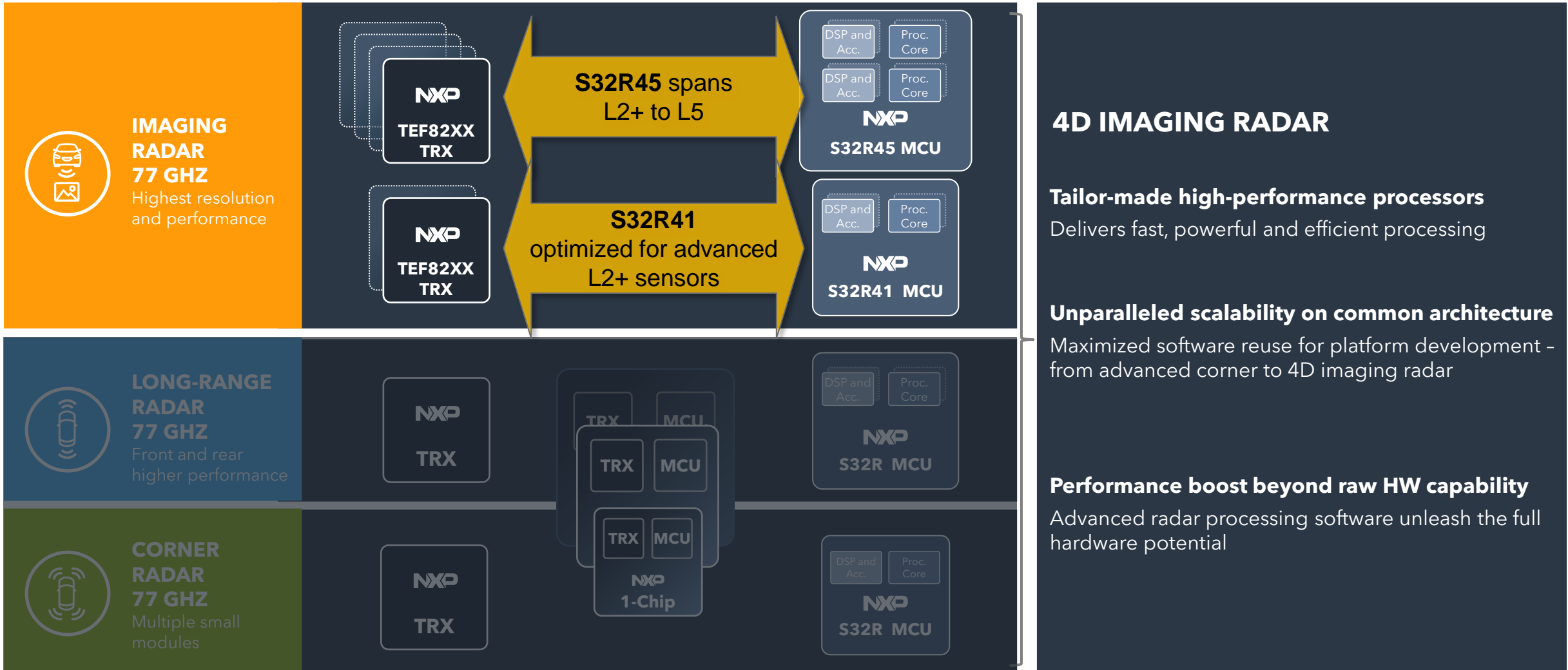


4D IMAGING RADAR BIFURCATION REQUIRES OPTIMIZATION FOR USE CASE

SCALABLE S32R4X ARCHITECTURE: EASY SCALING AND MIGRATION



RADAR PRODUCT FAMILY



4D IMAGING RADAR

Tailor-made high-performance processors
Delivers fast, powerful and efficient processing

Unparalleled scalability on common architecture
Maximized software reuse for platform development - from advanced corner to 4D imaging radar

Performance boost beyond raw HW capability
Advanced radar processing software unleash the full hardware potential



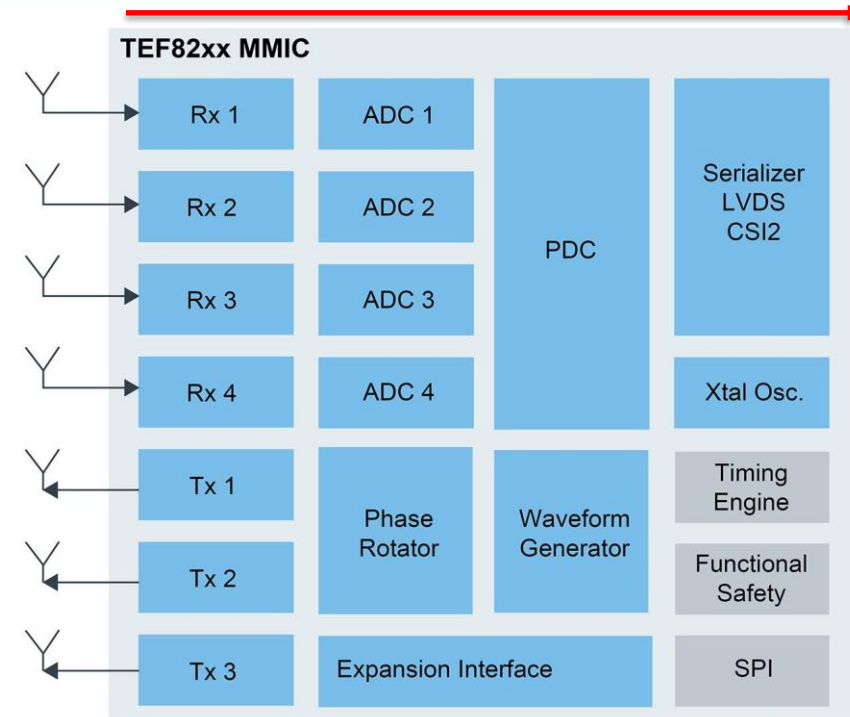
GEN 2 CMOS MMIC – TEF82XX

TEF82xx BLOCK DIAGRAM

OVERVIEW

The TEF82xx car radar transceiver is a single-chip, low power automotive FMCW radar transceiver for short-, medium- and long-range radar applications including cascaded high-resolution imaging radar, covering the full car radar frequency band from 76 GHz to 81 GHz. The fully integrated RFCMOS chip contains 3 transmitters, 4 receivers, ADC conversion, phase rotator and a low-phase-noise VCO. The device also includes built-in safety monitors and external interface capability for MIPI-CSI2 and LVDS.

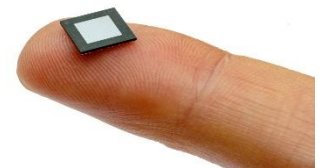
- Capability: Fully integrated RFCMOS automotive radar transceiver for 76–81 GHz
- Quality: ISO26262 compliant, ASIL Level B
- Functionality: Optimized for fast chirp modulation
- System: Fully compatible with NXP S32R29x and S32R45x radar microcontrollers



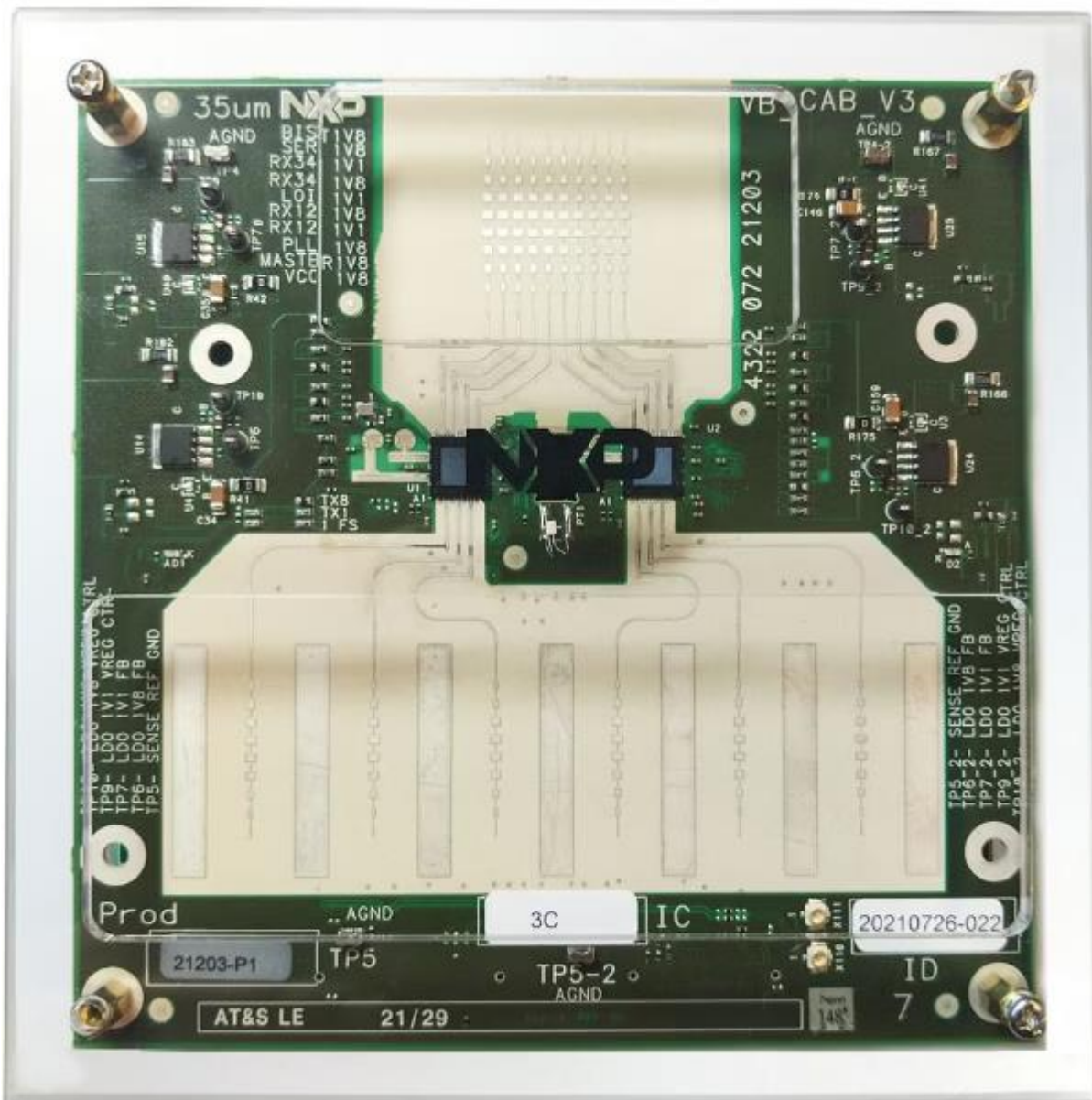
Channels	3 Tx (w/ phase rotator) and 4 Rx	Cascading	4 chips for up to 12 Tx and 16 Rx
Frequency Range	76–81 GHz	Package	165 pin eWLB 7.5 x 7.5 mm
Output Power	13.5 dDm	ADC Sample Rate	40 MS/s
Noise Figure	11.5 dB	Interface	CSI-2 or LVDS
Phase Noise	-95 dBc/Hz	Temperature Range	-40 to 135 °C Tj
Power Consumption	1.5 W (2 Tx 50%)	Effective Chirp BW	4 GHz

TARGET APPLICATIONS

- Cascaded imaging radar
- Adaptive cruise control
- Autonomous emergency braking
- Blind spot detection
- Front/Rear cross-traffic-functions
- Lane change assistance
- Parking



GEN 2 CMOS MMIC – TEF82XX EVB



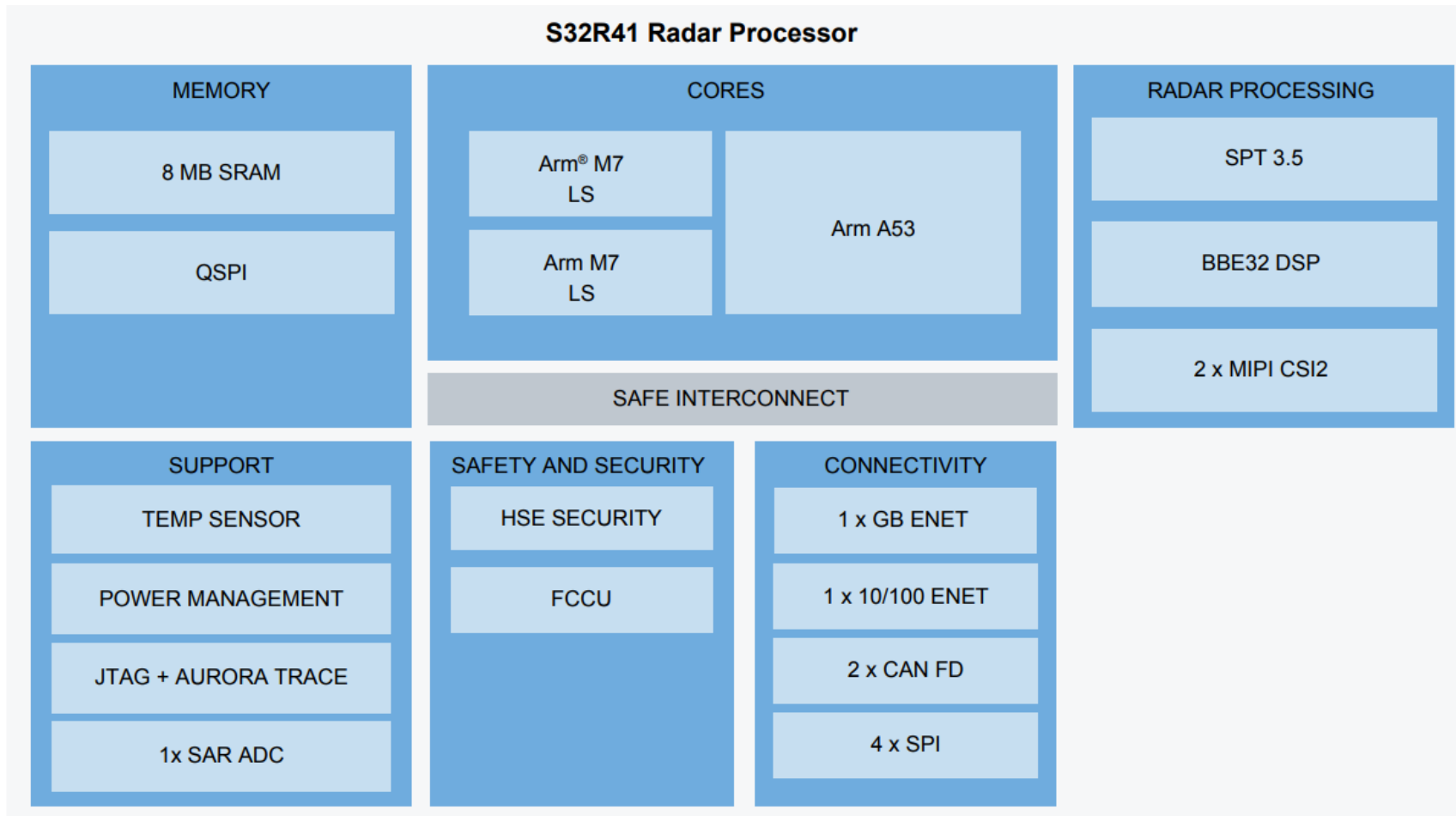
The TEF82-R294-KIT consists of the S32R294 radar application development board (RADB) and the dual TEF82xx customer application board (CAB). The S32R294 RADB is intended to provide a flexible development platform for the automotive radar product based on NXP radar microprocessor S32R294. The RADB supports up to two TEF82XX radar transceivers over CSI-2.

The TEF82-R294-KIT enables quick-start with TEF82xx GUI, TEF82xx control through IDEs: Python, MATLAB examples as well as support of S32R294 RSDK for development start. TEF82xx CAB, optimized for 78 GHz operation, contains dual TEF82xx (CSI-2) in cascaded setup, RF RX/TX channels wired to 6Tx x 8Rx antenna array.

The two boards feature combined power and high speed signal connectors to provide direct connection of the MIPI-CSI2 and SPI interfaces, allowing high speed data transfer to the MCU, along with SPI control signals and power domains to the RF transceiver. The TEF82-R294-KIT can be easily used to evaluate and develop radar application software and processing algorithms.

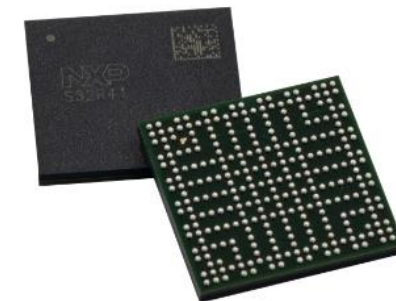
For more information, please reach out to your NXP sales representative.

IMAGING RADAR PROCESSOR – S32R41



KEY FEATURES

- Cortex-A53 @800 MHz,
- 2 Cortex-M7 lockstep pairs @400 MHz
- SPT 3.5 @600 MHz
- BBE32 DSP @600 MHz
- 8 MB SRAM with ECC
- HSE Security module
- 1x SAR ADC 8-channel
- 2x MIPI CSI2
- 2x Ethernet interfaces, 1x RGMII (1000 Mbps), 1x RMII (100 Mbps)
- 2x FlexCAN with FD
- ISO 26262 SEooC ASIL B(D)
- -40 °C to 150 °C (Tj) AEC-Q100 Grade-1
- 297-ball FCBGA, 11 x 11 mm



<https://www.nxp.com/products/processors-and-microcontrollers/s32-automotive-platform/s32r-radar-processing/s32r41-high-performance-processor-for-high-resolution-radar:S32R41>

IMAGING RADAR PROCESSOR – S32R41 EVB

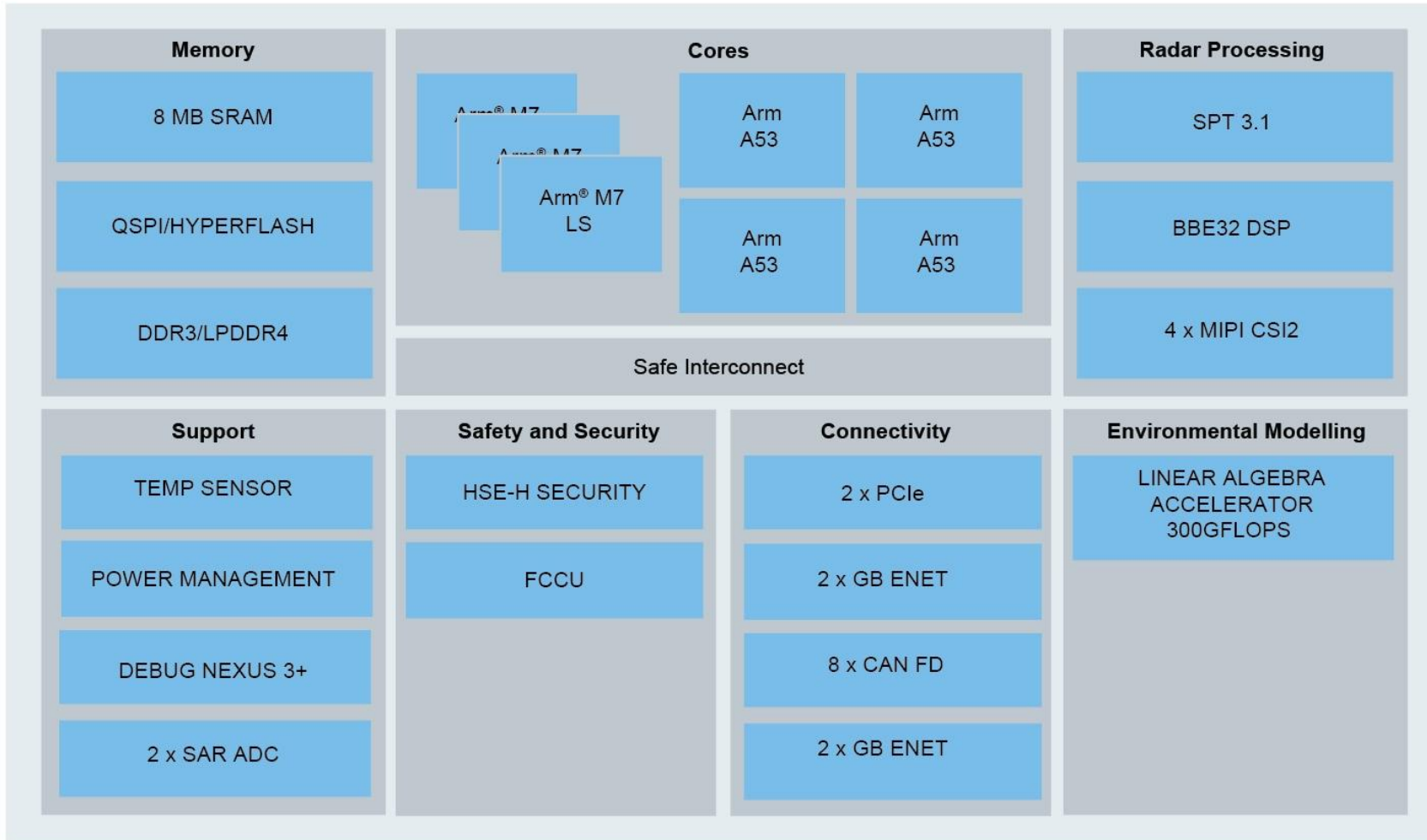


- S32R41 radar MPU
- Single 12 V external power supply input with necessary EVB and MCU voltages provided by an NXP Power Management IC (PMIC) solution
- Power supplied to the EVB via a 2.1 mm barrel style power jack; 12 V operation allows in-car use if desired
- Central power switch and regulator status LEDs
- Flexible MCU clocking options allow provision of an external clock via adaptor board (via MIPI-CSI0 connector) or 40 MHz EVB clock oscillator circuit. Solder pads allow selection between these external clocks.
- Boot mode selection via switches on board

- 64 Mb (16MB) Serial NOR Flash memory
- 1 Kb EEPROM connected to MCU via I²C

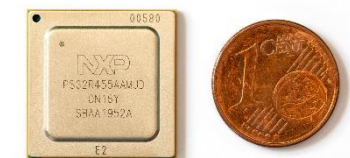
- Standard 20-pin ARM JTAG debug connector and 34-pin Nexus Aurora connector
- RGMII Gb Ethernet Physical interface IC, with RJ45 connector
- RMII / MII 100Mb Ethernet Physical interface IC with Matenet connector
- Two high speed connectors intended for direct use with the TEF820X CAB board
- All MCU signals readily accessible at a port-ordered group of 0.1" pitch headers
- 2x CAN-FD interfaces
- UART to Micro USB interface
- 2 user switches and 4 user LEDs, freely connectable
- 64 x 102 character LCD with DSPI interface (DSPI0)
- User reset switch with reset status LED

IMAGING RADAR PROCESSOR – S32R45



KEY FEATURES

- Quad Arm Cortex-A53 @ 800 MHz, flexible lockstep
- Triple Arm Cortex-M7 lockstep pairs @ 400 MHz
- LAX 1.0: >300 GFLOPS
- SPT 3.1 @ 600 MHz with integrated DSP and multi-threading
- 8 MB SRAM with ECC
- DDR3L-1600 with 16-/32-bit support and LP-DDR4-1600/3200 with 16-/32-bit support
- HSE High
- 2 x SAR ADC 16-ch.
- 4x MIPI CSI2
- PCIe 2 x Gen2/3, 2 lanes
- 2 x GbE 10/100/1000 Mbit/s
- 8 x FlexCAN with FD
- ISO26262 SEooC ASIL B(D)
- -40 °C to 150 °C (Tj) AEC-Q100 Grade-1



<https://www.nxp.com/products/processors-and-microcontrollers/s32-automotive-platform/s32r-radar-processing/s32r45-high-performance-processor-for-imaging-radar:S32R45>

NOVTECH™ RENAN™ BOARD

FULL IMAGING RADAR SOFTWARE DEVELOPMENT PLATFORM



Highlights

Full NXP Imaging Radar Chipset

- ✓ 4x [TEF8232](#)
- ✓ [S32R45](#)
- ✓ [NXP Auto-PMIC](#)
- ✓ [TJA1103](#) (10/100Mb, 1G in Q4/23)

Many Connection Options

- ✓ Dedicated 1Gb & 2.5Gb PHY
- ✓ PCIe 2xM.2 (NVMe)
- ✓ 2x CAN [TJA1462](#)

Flexible Debug and Storage

- ✓ JTAG & Aurora
- ✓ DDR4 ISSI 8Gb
- ✓ QSPI NOR Flash Q/O up to 2Gb ISSI
- ✓ SD Card Slot

Maximum GPIO adaptability with CPLD

- ➤ All SPI and GPIO between S32R45 and TEF8232s routed through CPLD
- Reconfigurable to mimic own design

NXP Imaging Radar Chipset

NovTech – designed
NXP-reviewed
NXP also internally uses this board

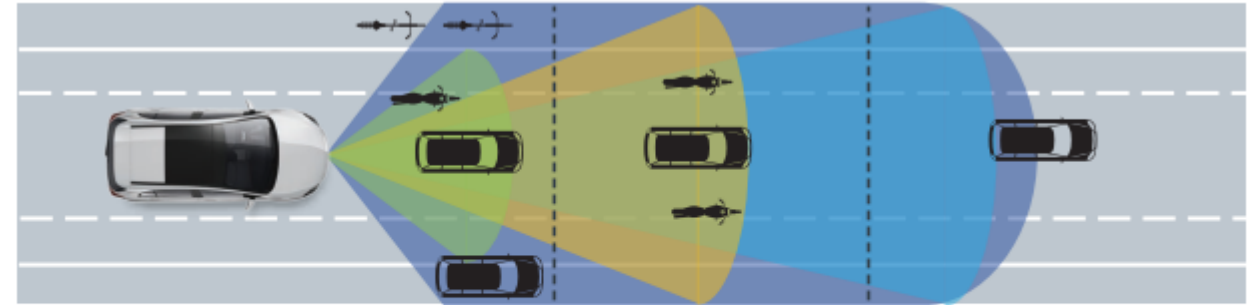
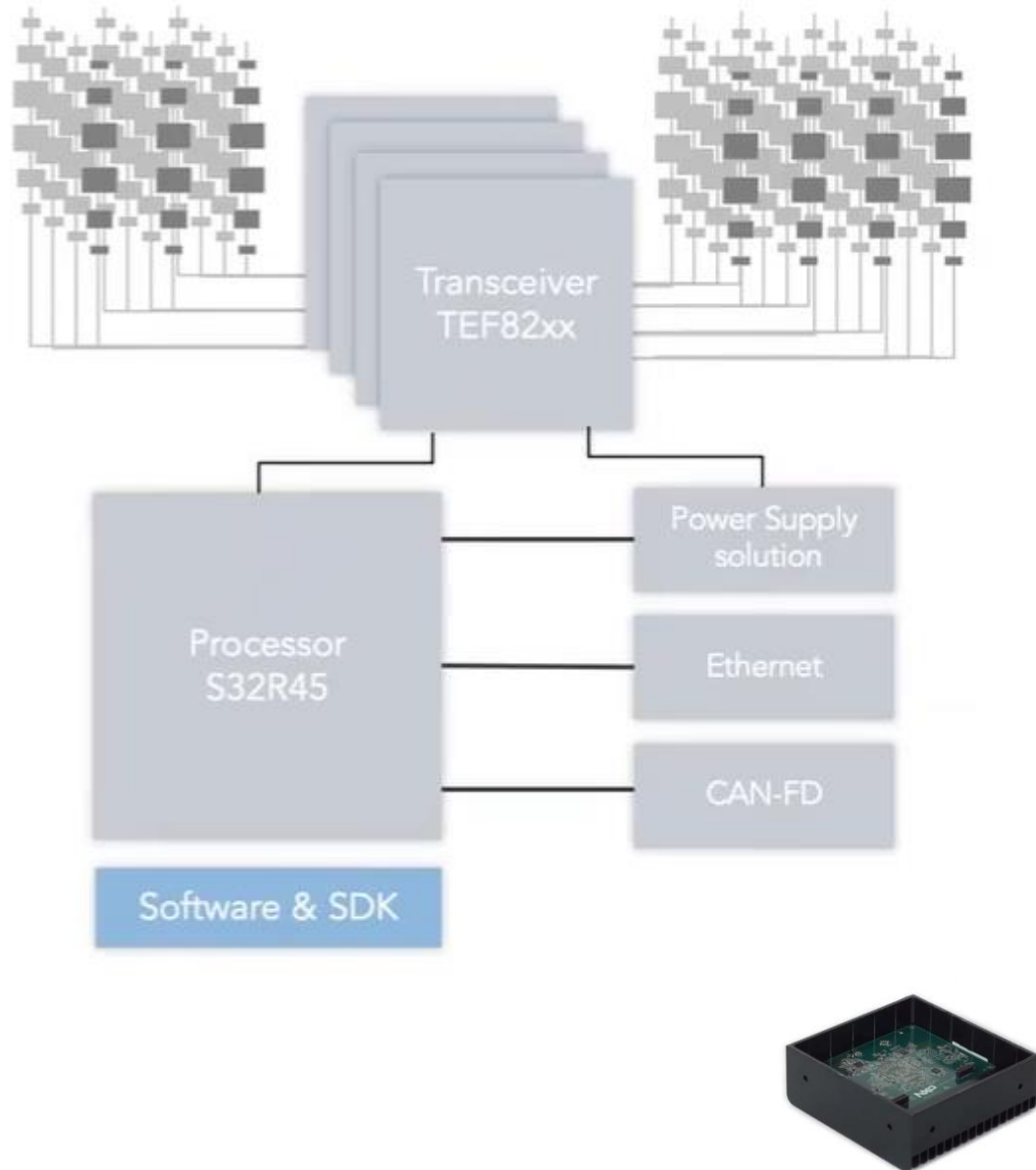
Full enablement package
Board // Schematics // GERBER Files // BSP // User Guides
Direct Support by NovTech, or NXP*

Customizable and Flexible
Software open and modifiable, Usable with RSDK
Hardware changes, on request (NovTech)
Flexibility through Networking BoM & CPLD

Sold directly through NovTech and Dist.



IMAGING RADAR 12TX16RX APPLICATION



Short-range (up to 50m):

- Enable autonomy in busy urban settings
- High-density point cloud across wide field of view
- Detect many objects, precisely separate small ones next to large ones and reliably classify in real time

Mid-range (50 .. 100m):

- Open country driving
- Discern multiple objects and interpret multi-object scenarios

Long-range (100 .. 300m):

- High-speed highway driving scenarios
- Detection of objects up to 300m
- Accurate sensing of speed for cruise control



Radar SDK Scope



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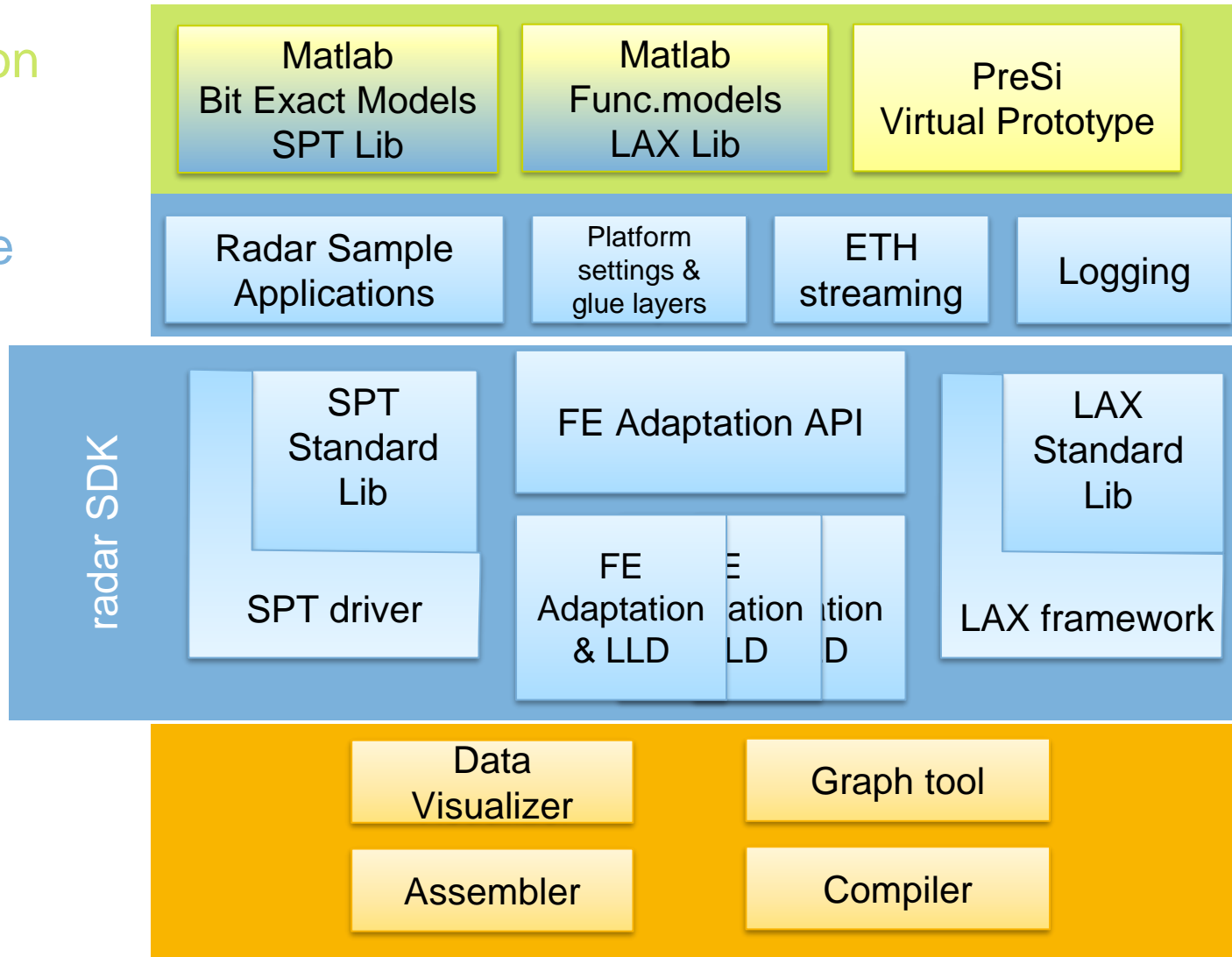


CONTEXT OF RADAR SDK

Emulation

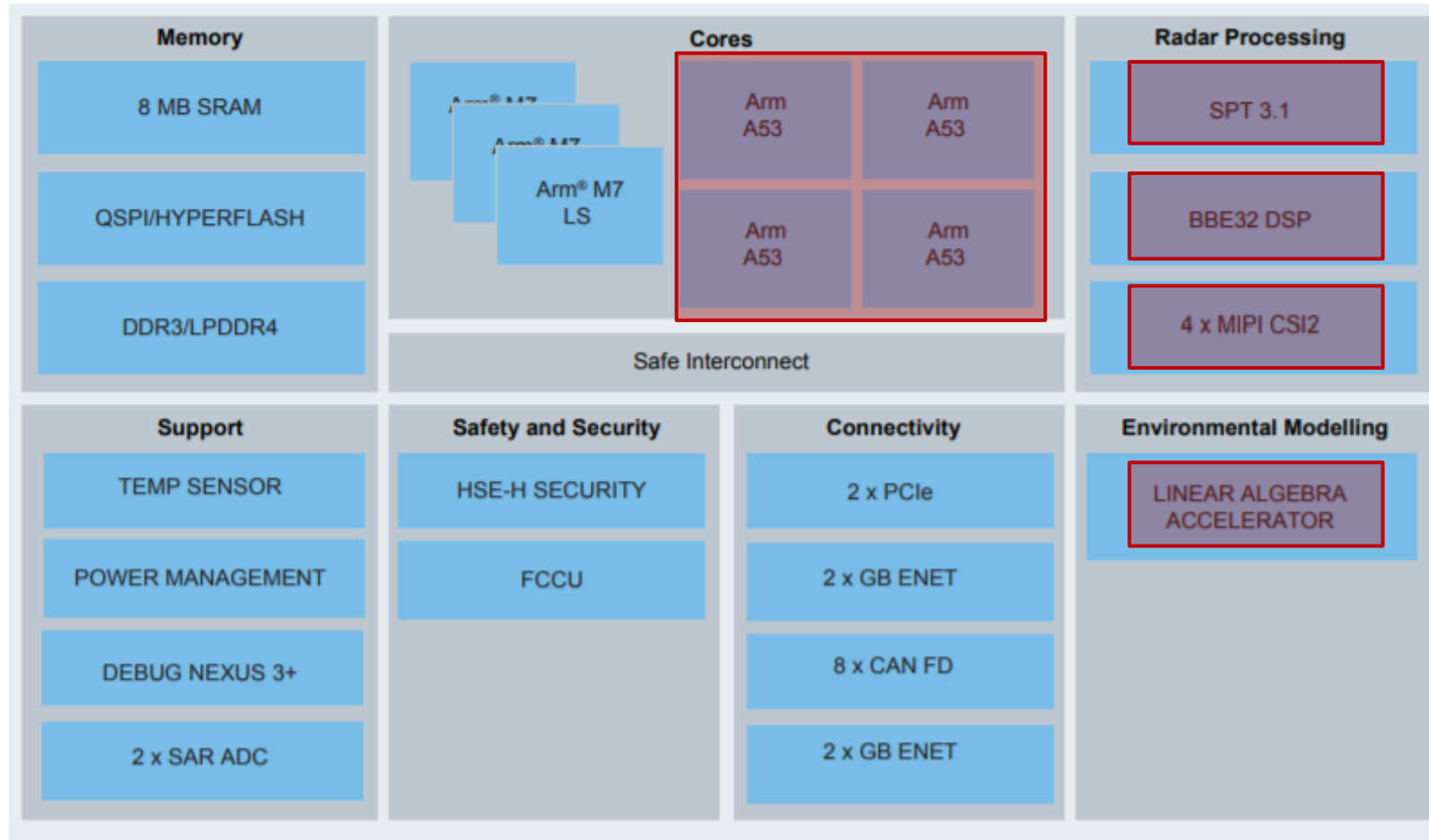
Software on target

Tools



- *RF Abstract API* for MMIC
- *SPI & CSI2 drivers*
- *SPT Driver*
- *SPT Kernels*
- *DSP Dispatcher* (BBE32)
- *DSP Algos* (examples)
- *LAX framework*
- *LAX kernel library*
- *Sample Apps* (with and without RF)
- *User Guide* (doxy generated)
- *Supported platforms:* S32R274 S32R372 S32R294 S32R45 S32R41

RADARSDK: SUPPORT FOR S32R45



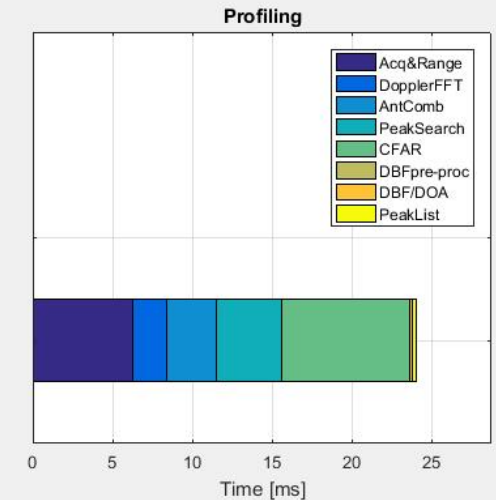
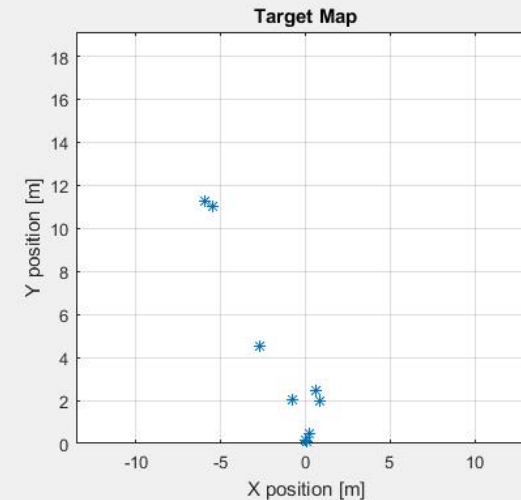
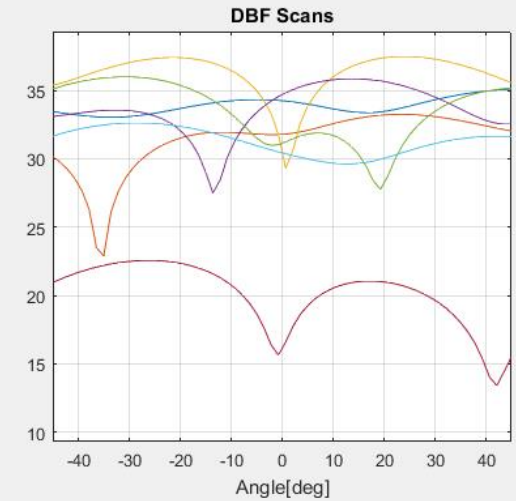
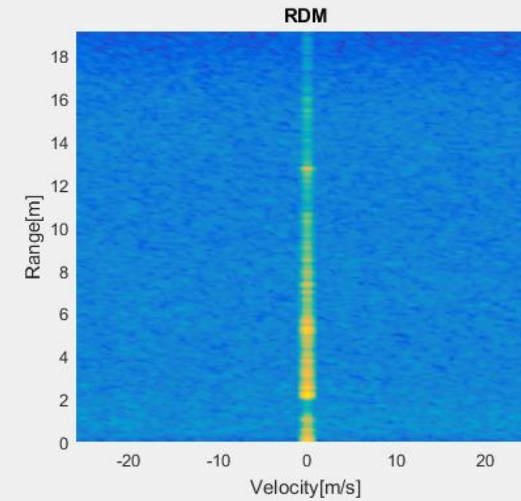
- Arm based platform
- Added DDR
- Support for Linux
- Added DSP and LAX accelerators
- Up to 4 frontends
- SPT 3.x – supports threads

SAMPLE APPS - OVERVIEW

- Apps:
 - Simple SPT example – no frontend, ADC data read from file
 - RSDK standalone sample app – frontend and radar processing chain
 - RFE capture
 - DSP dispatcher example
 - LAX standalone demos
- Tools
 - Matlab based signal visualization and analysis tool
 - Antenna calibration support
 - Profiling support
 - Debuggers: Lauterbach

DEMO VISUALIZER

- Support S32R45 EVB + TEF82xx.
 - Beamforming (Rx) & MIMO
 - RFE abstraction layer on TEF82XX low level driver
 - SPT kernels & CA-CFAR on BBE32





TECHNOLOGY SHOWROOM

JOURNEYS BY DESIRED ENGAGEMENT

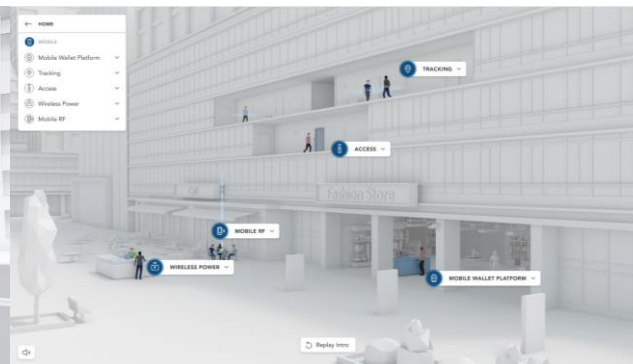
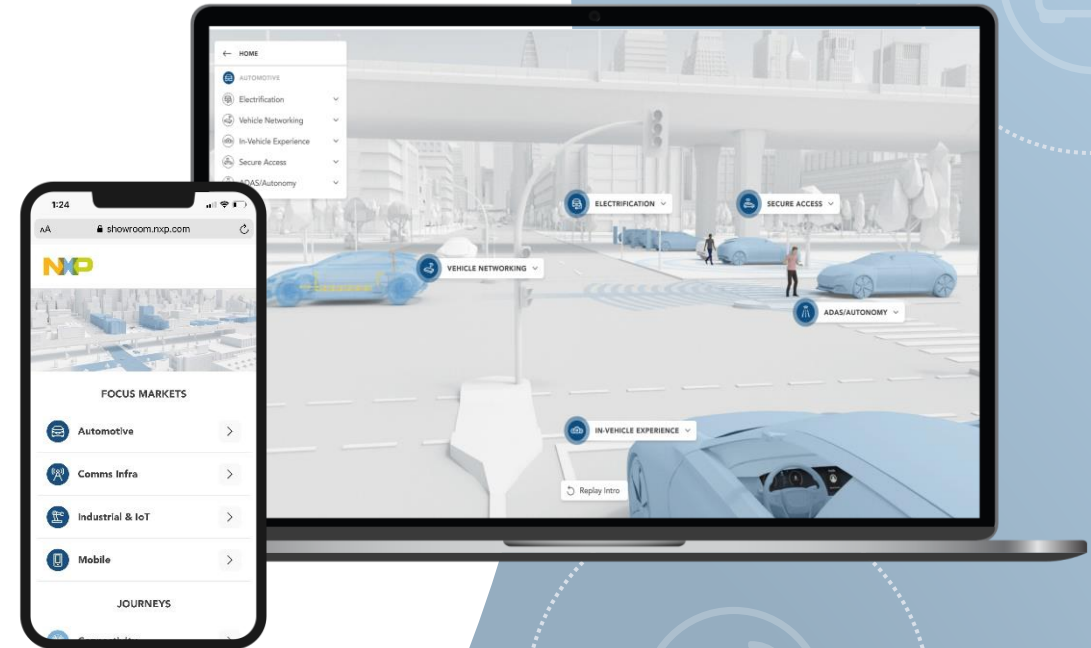
- Self-guided tour
- Live-streaming at set times
- Guided tours

40+ VIRTUAL DEMOS

- Focus on system solutions
- Set up along NXP verticals

JOURNEYS BY DESIRED FOCUS

- Edge & AI/ML
- Safety & Security
- Connectivity
- Analog



SHOWROOM.NXP.COM



We Recommend the Driving Automation and Radar Training Academy

- Visit the additional classes on this topic [here.](#)



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