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SECURE CONNECTIONS FOR A SMARTER WORLD

PUBLIC





What's RADAR: Radio Detection And Ranging

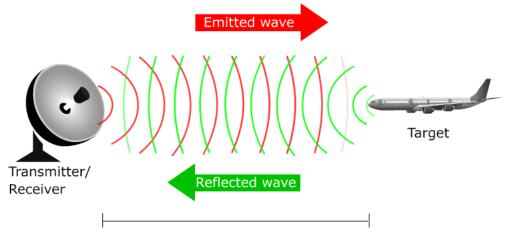
雷达: 无线电探测和测距

Radar is an object-detection system that uses radio waves to determine the range, angle and velocity of objects. 雷达利用无线电波来探测物体的距离,角度和速度

A radar system consists of:

- A transmitter producing electromag netic waves 发射机发射无线电波
- A receiver receiving return waves of object(s) 接收机接收物理反射回波
- A processor processing signal to determine properties of the object(s). 处理器处理信号以获得物 体的信息

| | Radar | Ultrasonic | Camera | Lidar |
|----------------|------------|-----------------|--------|-----------|
| Method | Radio wave | Mechanical wave | Vision | Laser |
| 探测方法 | 无线电 | 机械波 | 视觉 | 激光 |
| Distance | Long | Short | Medium | Long |
| 作用距离 | 长 | 短 | 中 | 长 |
| Night | Good | Good | Bad | Good |
| 夜晚工作 | 好 | 好 | 差 | 好 |
| Rain & Fog | Good | Affected | Bad | Bad |
| 雨雾天气 | 好 | 受影响 | 差 | 差 |
| Classification | Bad | Bad | Good | Medium |
| 目标识别分类 | 差 | 差 | 好 | 中 |
| Cost | Medium | Cheap | Medium | Expensive |
| 成本 | 中 | 便宜 | 中 | 贵 |





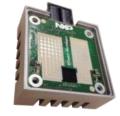
Automotive RADAR Technology

Industry standardizations & regulations...

- Measurement Concept FMCW (Frequency Modulated Continuous Wave)
- Carrier Frequency
 - 24 GHz
 - 77 GHz



- Antennas Patch antennas on "PCB" (printed circuit board)
- Electronic Components
 - Two IC packages or One IC package for primary functionality



- Plus support components (power supply, communications, EMC, etc.)



Automotive RADAR Technology

Basic Functional Blocks

- The radar have two major functional blocks:
 - RF Sensor (the RF "Front End")
 - Antennas
 - Signal creation and transmission
 - Signal reception and signal conditioning
 - Analog to digital sampling

Computational RF Sensor RADAR MCU - Distance - Velocity - Angle - ... - Adv functions RF Sensor G_t Signal Generation P_t Transmitter Chain P_r Receiver Chain Down Conversion

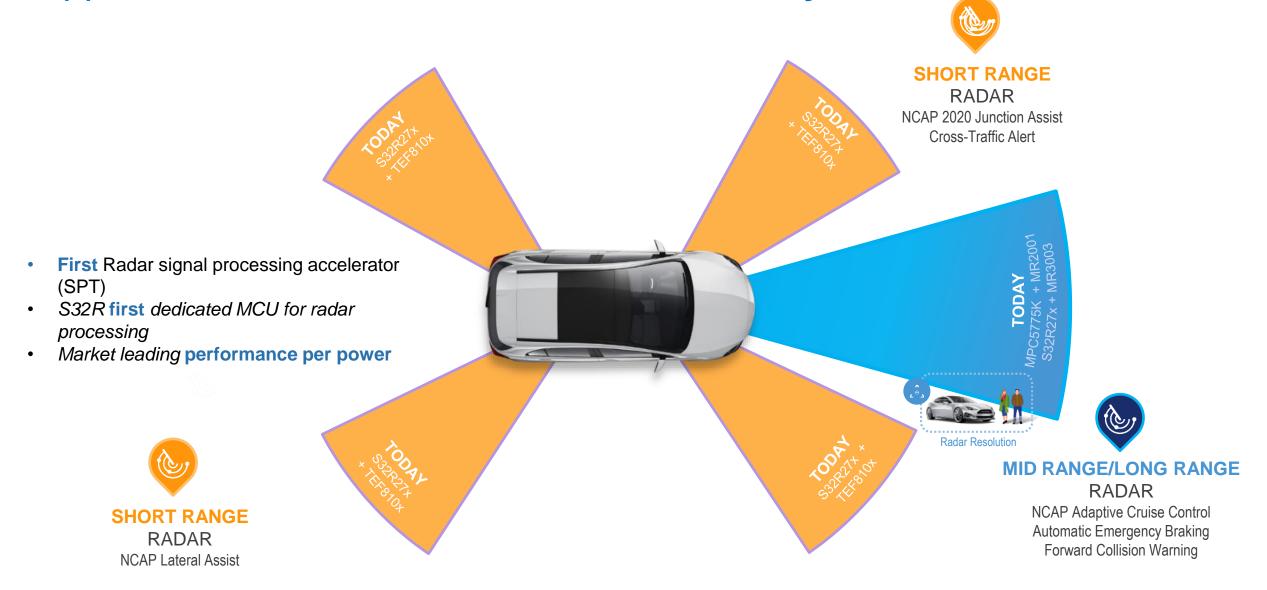
Computational (RADAR MCU)

- Convert sampled signal into frequency information
- Identify "targets"
- Calculate 1) distance, 2) relative radial velocity and 3) angle of target
- Advanced functions like classification & tracking





Application Context for SRR and MRR: Today







02

Regulations and demand 法律法规与市场需求





Regulations

- <u>EU:</u>
 - Official Journal of the European Union L325 欧盟公报
 - · ACEA (The European Automobile Manufacturers' Association) 欧洲汽车制造协会
 - Euro NCAP
- GC PV:
 - 《中国新车评价规程》2018 C-NCAP
 - Implementation 2018/7/1
 - 15pts (ESC 4 pts, AEB-V 8 pts, AEB-P 3pts) in ADAS box
 - ADAS is a must for 5 stars from 2019
 - · 《C-NCAP管理规则(2018年版)修订版》征求意见稿
 - LDW, BSD C2C, SAS are newly added systems for review.
 - Up to 2 pts can be obtained for three systems.
- GC CV:
 - 《营运客车安全技术条件》JT/T 1094-2016
 - Implementation 2018/5/1
 - AEBS, LDW & FCW mandatory for carriers > 9 meters
 - ~500k vehicles / year
 - 《营运货车安全技术条件 第1部分:载货汽车》JT/T 1178.1
 - Implementation 2020/Q3
 - AEBS, LDW & FCW mandatory for N3 vehicles (> 12 tons)
 - ~4M vehicles / year
 - · 《营运货车安全技术条件 第2部分:牵引车辆与挂车》JT/T 1178.2
 - Implementation 2020/Q3
 - LDW & FCW mandatory for carriers (> 12 tons)
 - AEBS mandatory for carriers maximum speed (> 80km/h)

Official Journal of the European Union L325 Intro

Background

• EU has updated the type approval requirements for motor vehicles and this has been formally published as <u>legislation</u> in the EU Journal. Safety systems relevant for radar starts in 2022 and is listed in the general safety regulation document published in EU Journal

Impact

- Best case scenario:
 - From 2024 all cars and trucks would have <u>1</u> front radar sensor for AEB, <u>2</u> rear corner radar sensors for Lane keep assist(accident prevention), <u>1</u> rear near range radar for reverse AEB: <u>4 units per car</u>.
 - From 2026 all cars and trucks would have <u>1</u> front radar for AEB, <u>2</u> front corner radars for pedestrian/cyclist detection, <u>2</u> rear corner radar sensor for Lane Keep assist and <u>1</u> rear near range radar for reverse AEB: <u>6 units per car</u>
- This might open up more opportunities for the future and potentially could lead to similar regulations in GC

Sensors

- The EU regulation does not mandate any specific technology to fulfill the technical requirements.
- Link: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2019:325:FULL&from=EN

Official Journal of the European Union L325 Summary

| Systems | Details |
|--|---|
| Advanced emergency braking for light-duty vehicles | Mandatory road deployment from 7 th July 2024 (Mandatory for Vehicle approval from 6 th July 2022) for all cars and trucks |
| Advanced Emergency Braking Systems Pedestrian/Cyclist | Mandatory road deployment from 7 th July 2026 (Mandatory for Vehicle approval from 7 th July 2024) for all cars and trucks |
| Blind Spot information system focusing on pedestrian/cyclist | Mandatory road deployment from 7 th July 2024 (Mandatory for Vehicle approval from 6 th July 2022) for large cars(>9seats)/trucks above 3.5tonnes |
| Reversing detection | Mandatory road deployment from 7 th July 2024 (Mandatory for Vehicle approval from 6 th July 2022) for all cars and trucks |
| Lane Departure Warning Systems | Mandatory road deployment from 6 th July 2022 for large cars/large trucks |
| Emergency lane keeping system | Mandatory road deployment from 7 th July 2024 (Mandatory for Vehicle approval from 6 th July 2022) FOR light CARS/light TRUCKS |

ACEA's Comments

FRONTAL FULL WIDTH IMPACT

What is it about?

Strengthening the safety systems of a vehicle for a carto-car frontal impact collision with an overlap of 100%.

Effectiveness? Proven to be effective.

Supported by ACEA?



DROWSINESS AND ATTENTION DETECTION

What is it about? Safety systems to assess the driver's alertness (for example by monitoring how long someone has been driving) and warn the driver to take a break when needed.

Effectiveness? Can make a real difference.

Supported by ACEA?



ALCOHOL INTERLOCK INSTALLATION FACILITATION

What is it about? Providing a standardised interface description to facilitate the fitment of alcohol-interfack devices in motor vehicles; eg to prevent recidivist drunk drivers from operating a vehicle under the influence

Effectiveness? Enables installation of interlock without driving up car prices.

Supported by ACEA?



of alcohol.

AUTONOMOUS EMERGENCY BRAKING

What is it about?

Autonomous emergency braking (AEB) systems start warning or braking automatically if a collision is imminent and the driver is not taking any action (or not fast enough).

Effectiveness? Very effective.
AEB can detect a potential
collision and activate the
brakes to avoid a collision, or at
least to mitigate the impact.

Supported by ACEA?



REVERSING

What is it about? Detection technology (eg a camera or sensors) to make the driver aware of people and objects at the rear of the vehicle when reversing.

Effectiveness? For

passenger cars and vans, this is an effective way of drawing the attention of the driver to vulnerable road users, such as pedestrians.

Supported by ACEA?



EMERGENCY STOP REAR IMPACT

SIGNAL

What is it about? Flashing

solutions) to indicate to

other road users behind

alert other road users.

Supported by ACEA?

slowing down.

the vehicle that the driver

is breaking heavily / rapidly

Effectiveness? Good way to

brake lights (or comparable

What is it about?

Strengthening the structure (eg passenger compartment and fuel tank) of a vehicle for a car-to-car rear impact collision.

Effectiveness? These design measures can limit the effect of a crash significantly.

Supported by ACEA?



LANE KEEPING SYSTEMS

What is it about? Safety systems that warn the driver if he or she leaves a marked lane without using the indicator or if the vehicle is drifting out of its travel lane.

Effectiveness? Very effective, but there is no evidence that lane keeping assistance (LKA) is more effective than lane departure warning (LDW).

Supported by ACEA?



ACEA believes that the requirement should be technology-neutral and that lane departure warning should be added as an alternative.

TYRE PRESSURE MONITORING

What is it about? Systems that monitor the air pressure of the tyres and report this information in real time to the driver, eg a low pressure' warning light.

Effectiveness? Can prevent accidents caused by under-inflated tyres.

Supported by ACEA?



ACEA believes that the requirement should be technology-neutral, allowing for both direct and indirect systems.

COMPLEX PROCEDURES TO SWITCH OFF SYSTEMS

What is it about? Proposal to switch off safety systems only one at a time, at standstill and with the parking brake engaged, following a complex sequence of actions.

Effectiveness? Not

recommended, as there are still specific situations in which systems have to be switched off. Should remain possible (see UNECE regulation).

Supported by ACEA?



FRONTAL OFF-SET IMPACT (<3.5T)

What is it about?

Strengthening the structure of a vehicle for a car-to-car frontal impact collision with an overlap of 40%.

Effectiveness? Heavy vehicles (eg vans and SUVs) risk jeopardising the safety of smaller cars. Moreover, heavier vehicles already have a high level of occupant protection.

Supported by ACEA?



SIDE IMPACT (<3.5T)

What is it about?

Strengthening the structure of a vehicle for side-impact accident types.

Effectiveness? Heavy vehicles (eg vans and SUVs) risk jeopardising the safety of smaller cars. Moreover, heavier vehicles already have a high level of occupant protection.

Supported by ACEA?



ADVANCED DISTRACTION RECOGNITION

What is it about? Safety systems capable of recognising the level of visual attention of the driver to the traffic situation and warning the driver if needed.

Effectiveness? Technology to identify a 'distracted' driver has strong limitations, as everybody drives differently. Facial recognition is also hampered by practical issues such as reflective glasses. Finally, using cameras to monitor drivers also raises serious privacy concerns.

Supported by ACEA?



Effective alternatives are enforcement, driver education, autonomous emergency braking, lane keeping systems, etc.

INTELLIGENT SPEED ASSISTANCE (ISA)

What is it about? Systems that actively prevent drivers from exceeding the speed limit using road-sign recognition cameras and GPS-linked speed limit databases

Effectiveness? In practice, ISA systems still show too many false warnings due to incorrect road signs or outdated information – something that most consumers would not accept. Moreover, cameras cannot anticipate all scenarios, eg when traffic signs are covered up.

Supported by ACEA?



Speed limit information (SLI) systems are an effective alternative.

PEDESTRIAN AND CYCLIST ENLARGED HEAD IMPACT ZONE

What is it about? Including the windscreen of the vehicle (besides the bonnet, etc) in the so-called 'head impact zone'. In practice, this means that windscreens would have to be soft to reduce the impact.

Effectiveness? Very limited, as today's windscreens are already soft. Research shows that autonomous emergency braking systems are much more effective in protecting vulnerable road users than enlarging the head impact zone.

Supported by ACEA?



Market Trends: Spurring Radar Growth

NXP Judged Radar Market – Global

Autonomous Driving Higher Resolution

Highway Pilot (L3)
Garage & Park Pilot (L3)
Highway Pilot 2.0 (L4)



Comfort Features
More sensors per car

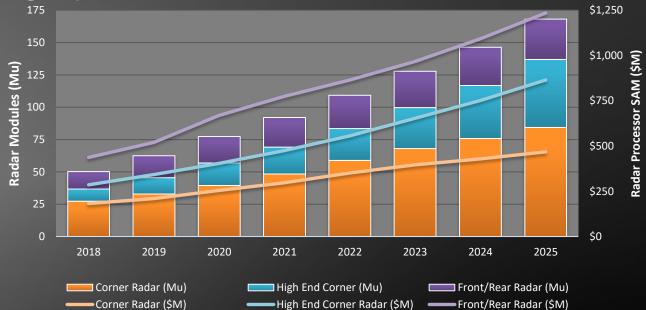
Traffic Jam Assist (TJA)
Lane Change Assist
(LCA)

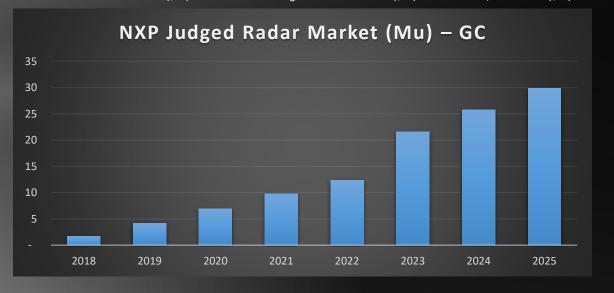


NCAP Safety

More cars with radar

Adaptive Cruise Control (ACC)
Automatic Emergency Brake (AEB)
Blind Spot Detection (BSD)





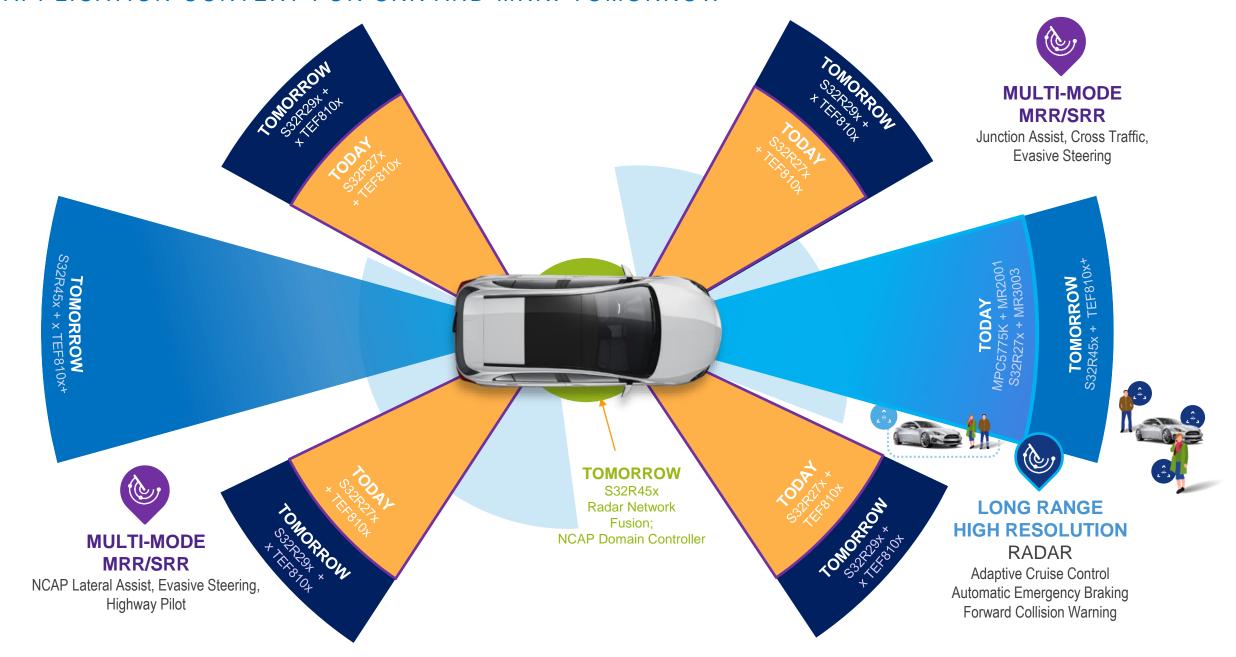




NXP Provides Full Products Portfolio

| | MMIC | MCU | Power SBC | CAN PHY | ENET PHY |
|------------------------------|--------------------|--------------------|-------------------|---------|----------|
| LRR 3Tx4Rx | TEF8102 | S32R274 S32R264 | FS84x0 | TJA104x | TJA1101 |
| MRR 3Tx4Rx | TEF8102 | S32R274 S32R264 | FS84x0 | TJA104x | TJA1101 |
| SRR/USRR 2Tx4Rx 1Tx3Rx | TEF8105 TEF810x | S32R372 | FS84x0 | TJA104x | |
| | | 下一代解决 | 分案 | | |
| Platform I | TEF812x | S32R294 | FS84x0/ PF502x | TJA104x | TJA1101 |
| Platform II | TEF812x | S32R45 | FS84x0/ PF502x | TJA104x | TJA1101 |

APPLICATION CONTEXT FOR SRR AND MRR: TOMORROW



Dolphin One Page



TEF810X 毫米波雷达收发芯片

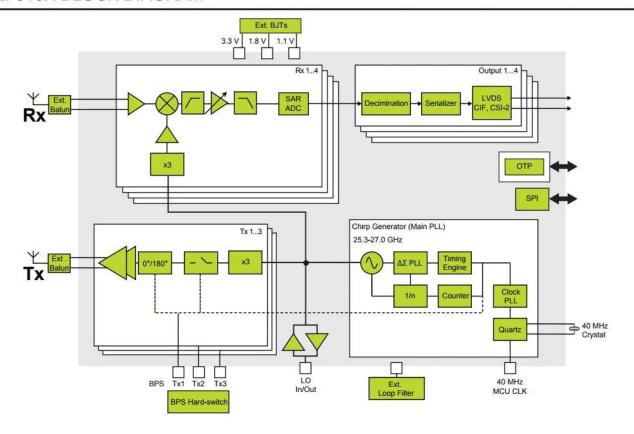
TEF810X 是一款高度集成的汽车FMCW雷达芯片。

支持76-81GHz的工作频段,覆盖了汽车毫米波雷达应用的全频带。收发芯片包含了3路发射,4路接收,ADC内置采样及低噪声VCO。芯片同时内置多种安全监测模块并支持MIPI-CSI和LVDS数据传输接口。

- 基于高度集成的RFCMOS工艺
- 兼容ISO26262, ASIL B 等级
- 优化的快速扫频调制
- · 支持汽车级温度范围 (-40°C到135°C)
- 高度兼容NXP S32R 系列雷达处理器

| 通道数 | 3TX(W/BPSK) & 4RX | 级联支持 | 4 chips for up to 12TX and 16RX with Master Device | |
|--------------|--|---------|--|--|
| 频率范围 | 76-81GHz | 封装 | 155 pin eWLB 7.5x7.5 mm | |
| 检山地家 | 12dBm Typ (76-78 GHz) | ADC 亚丝索 | 20145/2 | |
| 输出功率 | 11dBm Typ (78-81 GHz) | ADC 采样率 | 20MS/s | |
| 噪声系数 | 12dBm Typ (76-77 GHz) | 接口 | CSI-2 & LVDS | |
| 噪 巴分致 | 13dBm Typ (77-81 GHz) | | | |
| 相位噪声 | -90dBc/Hz Typ 0.5GHz chirp (76-77GHz) | 温度范围 | -40 to 135 ℃ Tj | |
| 功耗 | 1.2W Typical (2TX 50%) | 扫频带宽 | 2GHz | |

TEF810X BLOCK DIAGRAM



目标应用场景:

- 自适应巡航(ACC)
- 自动紧急刹车控制(AEB)
- 盲点检测(BSD)
- 变道辅助(LCA)
- 停车辅助(PA)
- 后侧横向来车警告(RCTA)
- 前侧横向来车警告(FCTA)
- 后侧碰撞避免(RCA)
- 茧式雷达
- 成像雷达



S32Rx One Page

S32R274 毫米波雷达处理器 基于Power PC架构的MCU,可用于汽车及工业应用

特性:

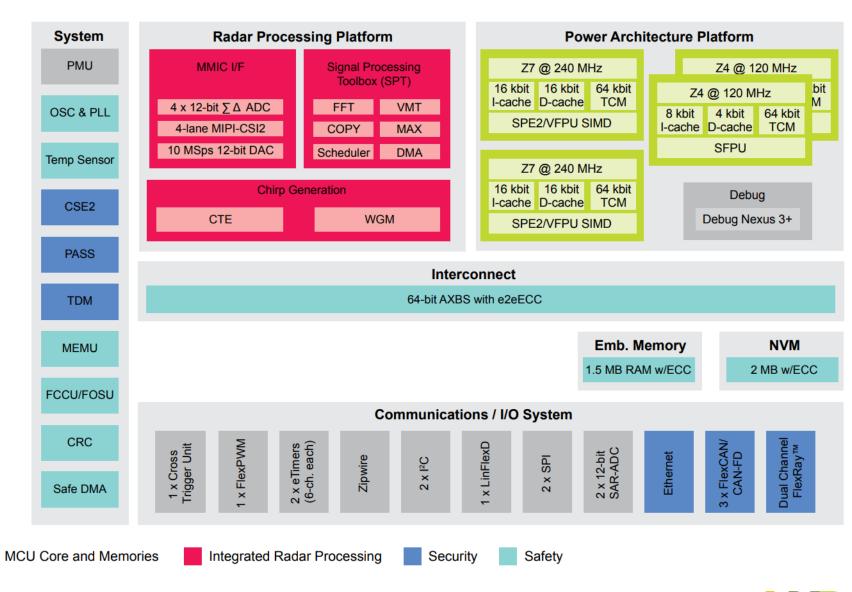
- 1. 两个高性能处理PowerPC e200z7 32位内核
- 2. 一个安全处理PowerPC e200z4 32位锁步内核
- 3. 专用雷达信号处理硬件加速器SPT 2.0
- 4. 支持到ASIL-D功能安全应用
- 5. 支持信息安全服务的硬件引擎CSE2

相关支持工具:

- 1. AUTOSAR sMCAL
- 2. S32 Design Studio IDE, 支持第三方插件,编译器,调试器。
- 3. 编译器支持WindRiver和GreenHills
- 4. 调试器支持Lauterbach, P&E, iSystems
- 5. SPT 2.0图形编辑工具和Radar SDK
- 6. 集成在S32DS IDE中的底层驱动SDK
- 7. 基于Matlab的SPT2.0开发工具

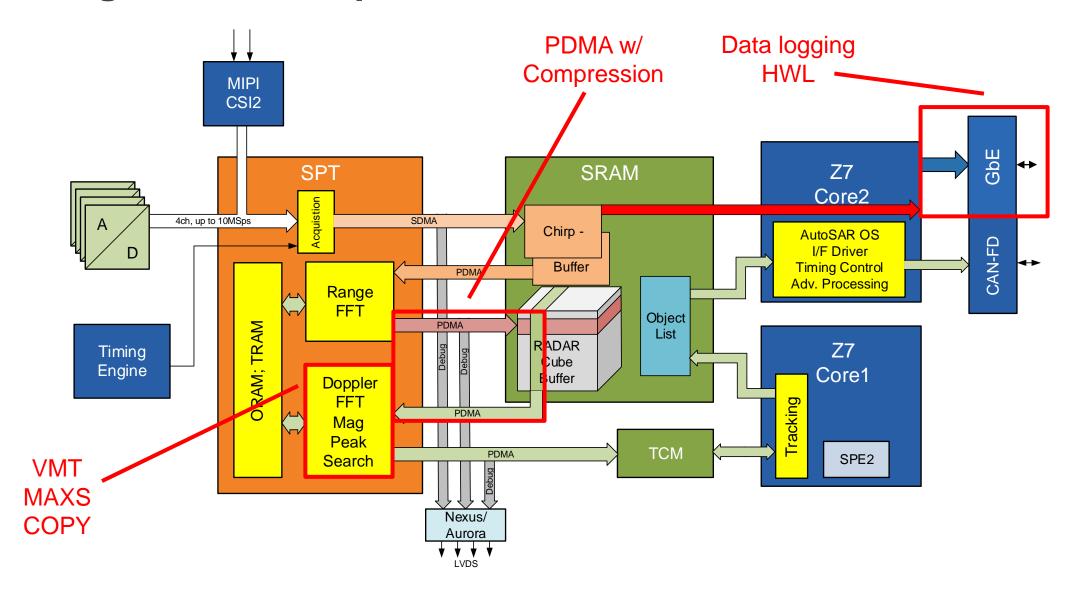
应用场景:

- 汽车毫米波雷达应用
- 1.支持中短距雷达应用,例如变道辅助LCA,盲点检测 BSD等
- 2.支持长距雷达应用,例如自适应巡航ACC,自动紧急制动AEB等
- 非汽车雷达应用
- 1. 安防监控
- 2. 智能家居,手势识别等
- 3. 工业自动化,例如位置检测等





SPT Algorithm Example 雷达信号加速器算法样例





RDK-S32R274 – Reference Platform for Automotive Radar

Key Platform Features:

- Targeted at ACC/AEB applications
- Leverages NXP market leading radar processor
- Built on automotive grade radar SDK & HW



- NXP/CEI Radar Reference Platform
 - Complete HW & SW package
 - ASIL-B reference application ready
 - FCC/CE certified design
- Reference BOM ready for mass market
 - Radar Front End: TEF8102
 - Radar Processor: S32R27x
- Availability: Order Today for \$3500!

- Package Includes:
 - HW Reference design in production housing
 - NXP RF Front end with Antenna
 - NXP S32R Processor
 - Ethernet enabled output to PC
 - Reference application (app notes & code available)
 - NXP development environment enabling customer optimization





RDK-S32R27: Out of the Box Experience





Overview

This quick start guide provides the necessary information to get the RDK system powered on and functional using the chirp configuration GUI.

Development Kit Contents

The RDK-S32R274 includes the contents listed in Table 1.

Table 1 - Development Kit Contents

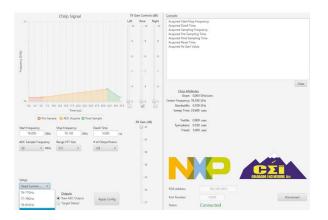
| Component | Description | Note | |
|------------|---|-----------------------------------|--|
| | RDK-S32R274 Enclosure | | |
| | iScan Edge 3 (iScan-P-S32R): Processor Module | Pre-installed in RDK Enclosure | |
| | iScan Prizm 2 (iScan-A- TEF8102): 77GHz Antenna Module | Pre-installed in RDK Enclosure | |
| Cables | Ethernet Cable (14ft), Power Adapter Cable | | |
| AC Adapter | 12 Volts - 1.6 Amps | | |

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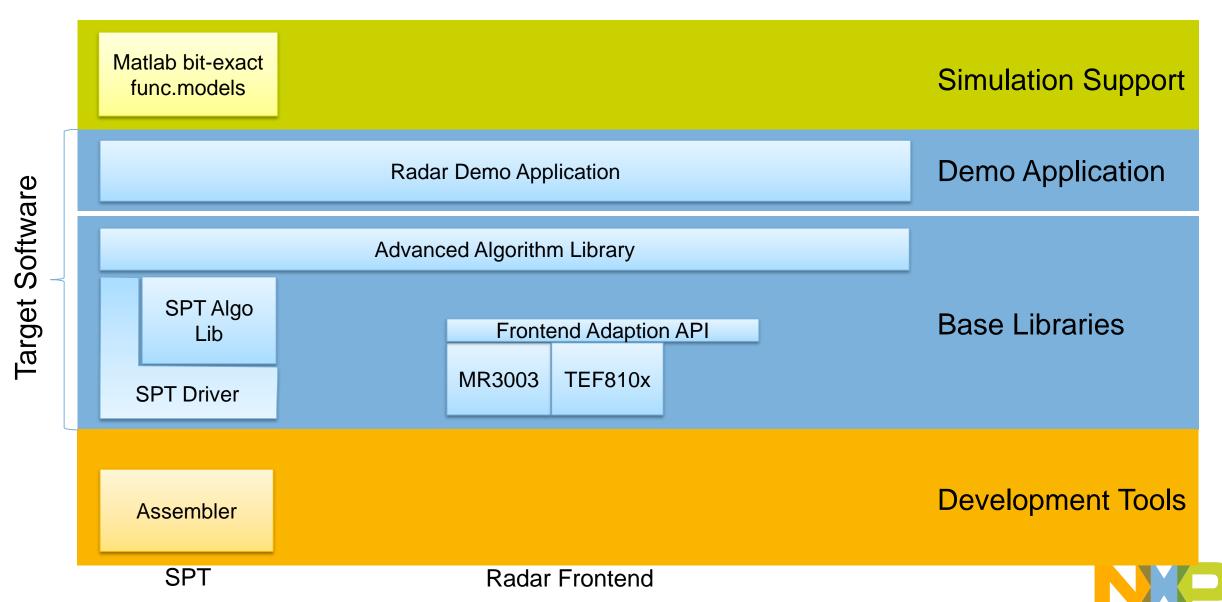
RDK-S32R27: SW & Capabilities

- Sample Applications ready to use
- Raw ADC data output ready
- Graphical Interface enabling development



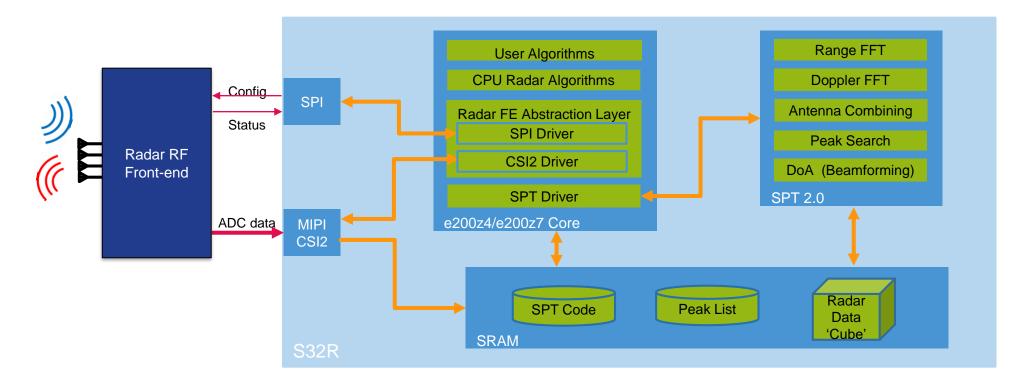


S32R274 Radar SDK



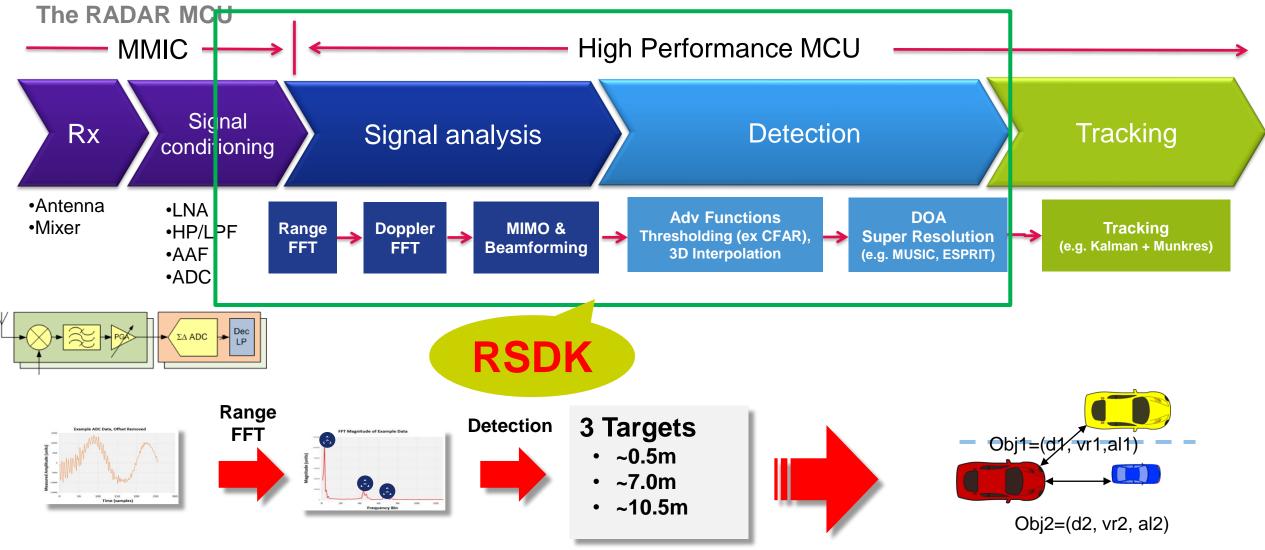
Radar Software Development Kit - RSDK

- Radar SDK provides basic radar processing algorithms and device drivers for S32R hardware devices.
- Facilitate radar algorithm development (using SPT kernels, Matlab models), creation of higher level algorithms (starting from the basic blocks supplied with RSDK)
- Easy application development by integrating driver and platform support.



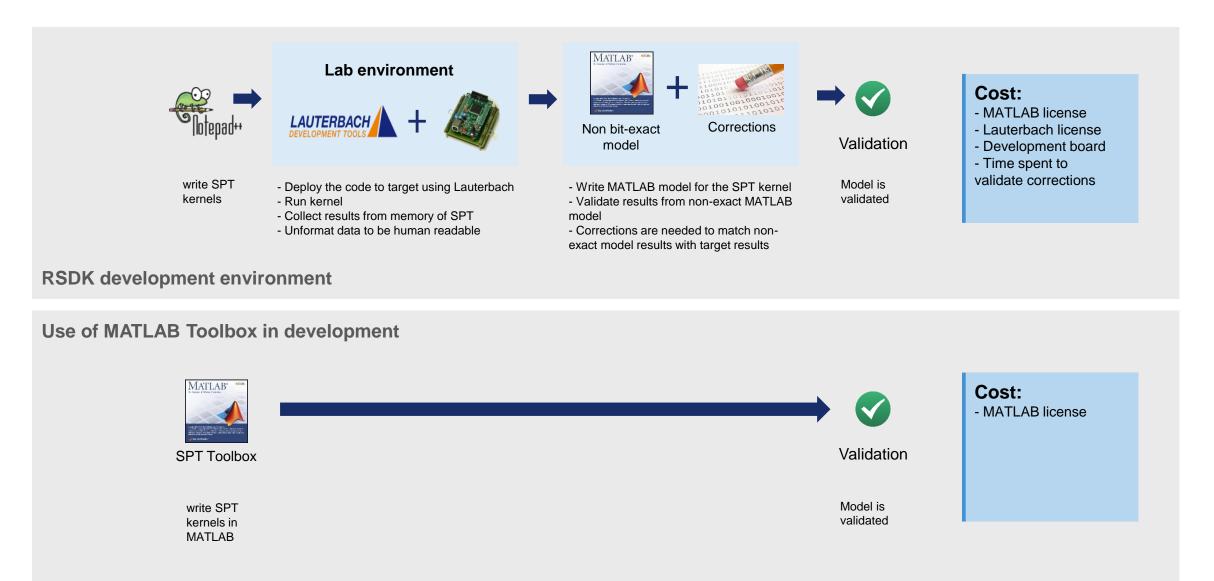


Typical Automotive RADAR Processing





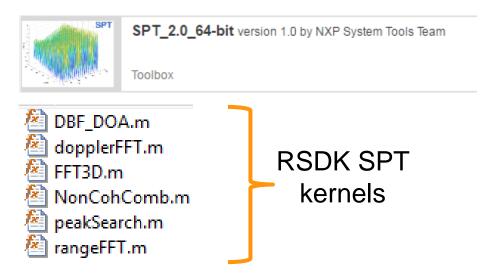
Comparison of algorithm validation – MATLAB vs target





MATLAB Environment

- Support for MATLAB on 32-bit and 64-bit (R2015a, R2016a, R2016b, R2017a, R2017b)
- Must install the SPT Toolbox add-on (see link)
- RSDK Bit-exact kernel scripts are included in release package
 - Each MATLAB '.m' script represents a kernel
 - Scripts dynamically adapt to samples/chirps configuration



- Advanced users can use the Design Toolbox to design their own SPT kernels in MATLAB
 - In the simulation environment we can ignore the SPT memory layout demands
 - Once the desired simulation results are achieved the MATLAB script must be translated into SPT code



Links

Radar SDK:

https://www.nxp.com/products/processors-and-microcontrollers/power-architecture/s32r-radar-mcus/s32r-radar-microcontroller-s32r27-automotive-industrial-radar-applications:S32R27?tab=Design_Tools_Tab

or...

- 1. Go to www.nxp.com
- 2. Search 'S32R' and click the first result
- 3. Click 'TOOLS & SOFTWARE'

