Infineon 77GHz Imaging Radar Solutions [1]

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Radar and ADAS Domain Applications
September 27, 2024

Agenda

SAE ADAS / AD Levels – where is 77GHz Imaging Radar needed? [1]

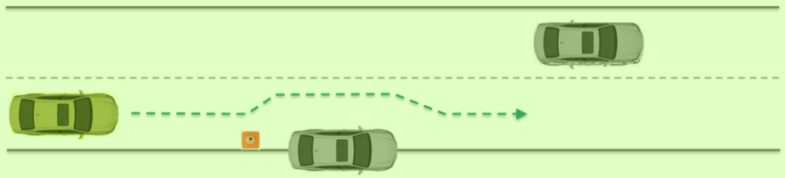
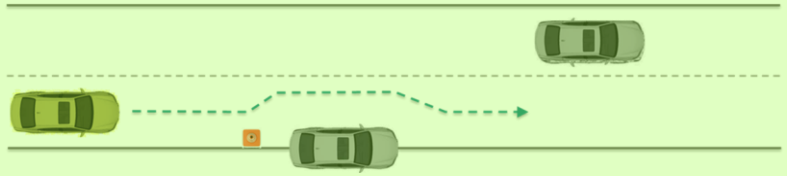
SAE ADAS/AD Level	Definition	Use case example
L5	Autonomous driving **without limited** ODD*	Robotaxis (worldwide)
L4	Autonomous driving in **specified** ODD* Driving function not overtaken by driver	Robotaxis (limited area)
L3	Autonomous driving with **limited** ODD* Driver is required to take over	Traffic jam pilot
L2+	L2 with wider ODD*	Lane centering **and** Auto Cruise Control
L2	Steering support **and** velocity control support	Lane centering **and** Auto Cruise Control
L1	Steering support **or** velocity control support	Lane centering **or** Auto Cruise Control
L0	AEB function	Auto Emergency braking

[2] [3] *ODD = Operational Design Domain, which refers to the set of driving conditions such as weather, geography, time of day, traffic and road conditions.

Infineon Definitions [4]

- HD Imaging Radar [5]
  ≥ 16T16R
- 4D Imaging Radar [6]
  8T8R – 12T12R
- Standard Radar [7]
  ≤ 4T4R

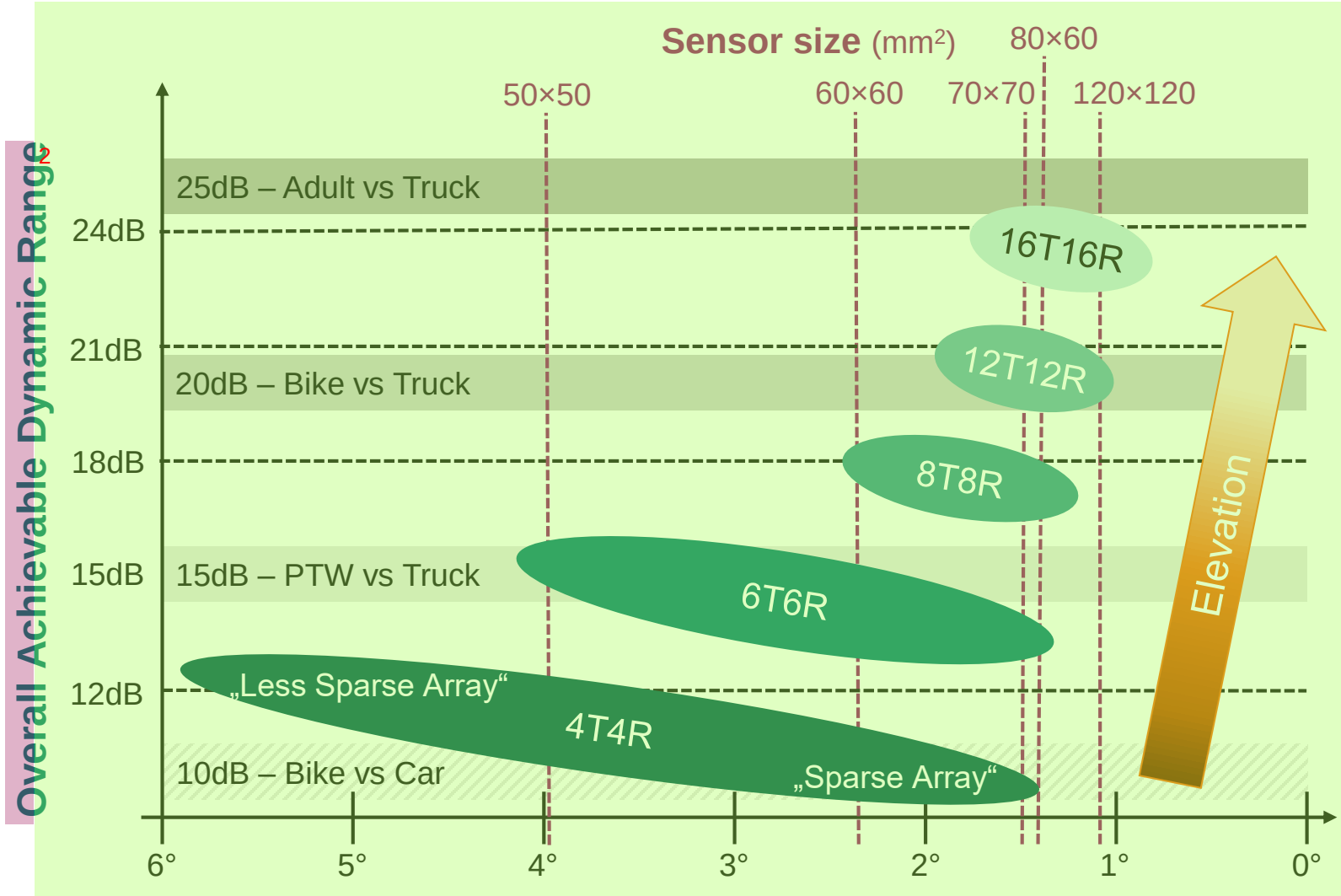
Different driving expectations between L2+ and L3/L4 needs different sensor configuration and much better performance [1]

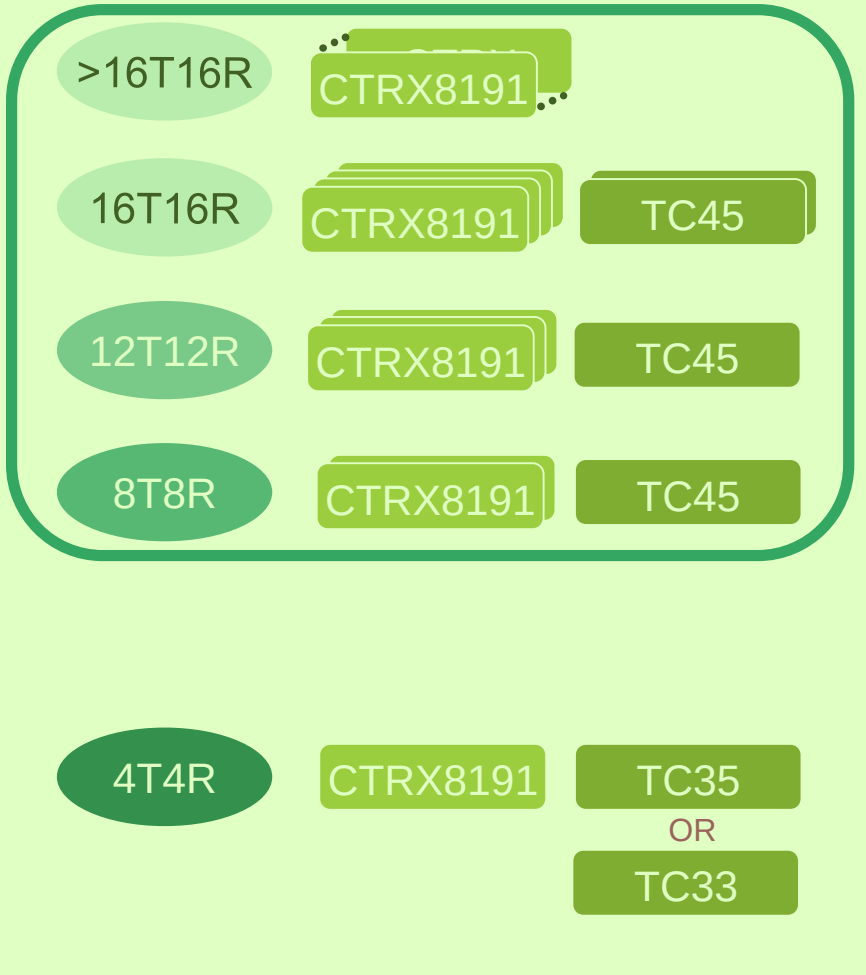
Vehicle confronted with stalled vehicle on the side of the lane and vehicle on adjacent lane [2]	
 **L2+**	 **L3/L4**
Ego car should stop	**Ego car should maneuver**
Azimuth angular resolution: 1° (3m @ 200m distance)	Azimuth angular resolution: 0.3° (1m @ 200m distance)
Virtual channel number: < 256 (8x8 – 16x16)	Virtual channel number: typ. > 1000 (e.g. 24 x 24 = 576, up to 48x48 = 2304)
Number of detections: < 2000	Number of detections: > 2000
Cost / performance optimization -> 4D Imaging	**Massive improved sensor -> HD Imaging**

From L3 onwards increase performance is paramount [3]

Separability drives Dynamic Range, Azimuth & Elevation resolution

Infineon's radar solution scales RF channels to match separability needs.



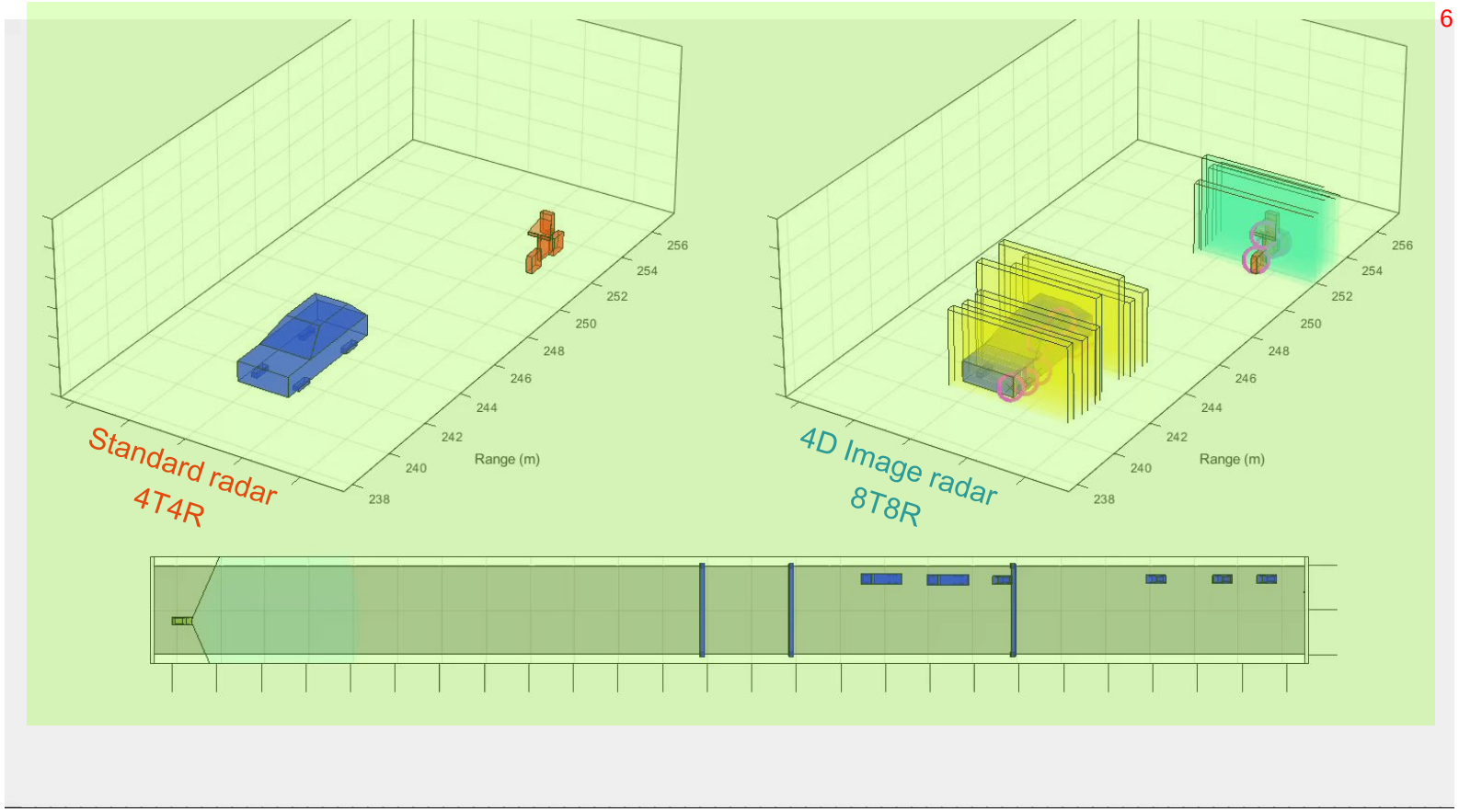


Resolution[1)] in Azimuth

[1)] high-resolution algorithms not included

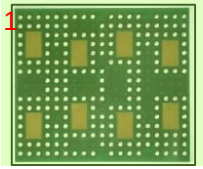
8T8R CTRX8191F enables 4D and HD Imaging Radar Solutions with excellent RF Performance and low-cost RF Laminates. [1]

- First 8T8R Antenna Feed-in-Package cascading [2]
- Excellent detection range: > 250 m [3]
- Excellent azimuth angular performance with elevation angle estimation [4]
- Premium software packages and CarKit soon available to support Fast Time to Market [5]



[6]

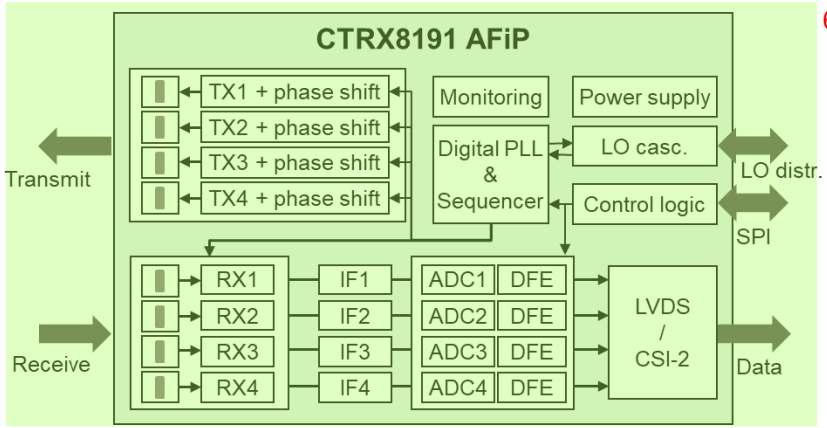
CTRX8191F enables cascaded 4D/HD Imaging Radar solutions with excellent RF performance and low-cost RF PCB´s.

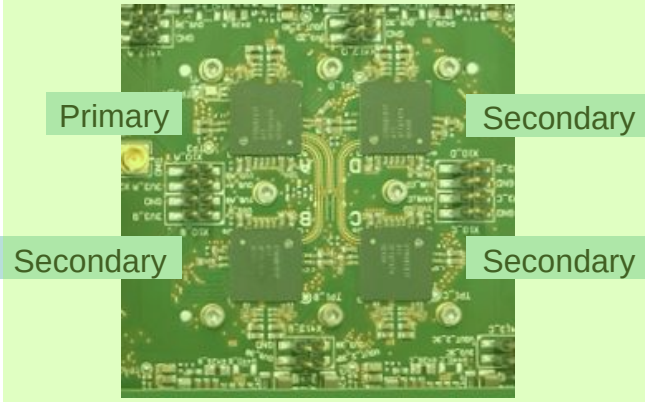


Future-proof performance and flexibility to cope with future automotive radar needs.

CTRX8191F key characteristics:

- 4 Transmitters + 4 Receivers
- Digital PLL enables situation based **on-the fly modulation adaption,** e.g. from **highway** (high speed) **to parking** (high resolution)
- **Cascading** via 26GHz LO self-feeding ports (1x LO_{OUT}, 2x LO_{IN}) allows low-cost substrates and symmetrical designs for fast TTM
- Antenna-Feed-in-Package (AFiP) for **lower system cost** and **larger system link budget**
- **MMIC platform approach** enables scalable Imaging Radar segments from 8T8R up to 40T40R





AURIX™ TC45x enables 4D imaging Radar solution by offering Scalability, Large internal SRAM and Efficient Radar Processing

1

- Monolithic MCU with **integrated SRAM** and **NVM**
  - Embedded **10MB** SRAM and **4MB** NVM hence no external memory needed

2

- Dedicated **Radar Direct Memory Access (DMA)**
  - Reduced Latencies up to **400MBins/s** for **fast data transfer** from and to Radar SRAM with large bandwidth

3

- **Signal Processing Unit (SPU3.0)** for radar **pre-processing**
  - Up to **800Msamples/s** sampling rate with **interference detection**, **mitigation** / **repair** functionality

4

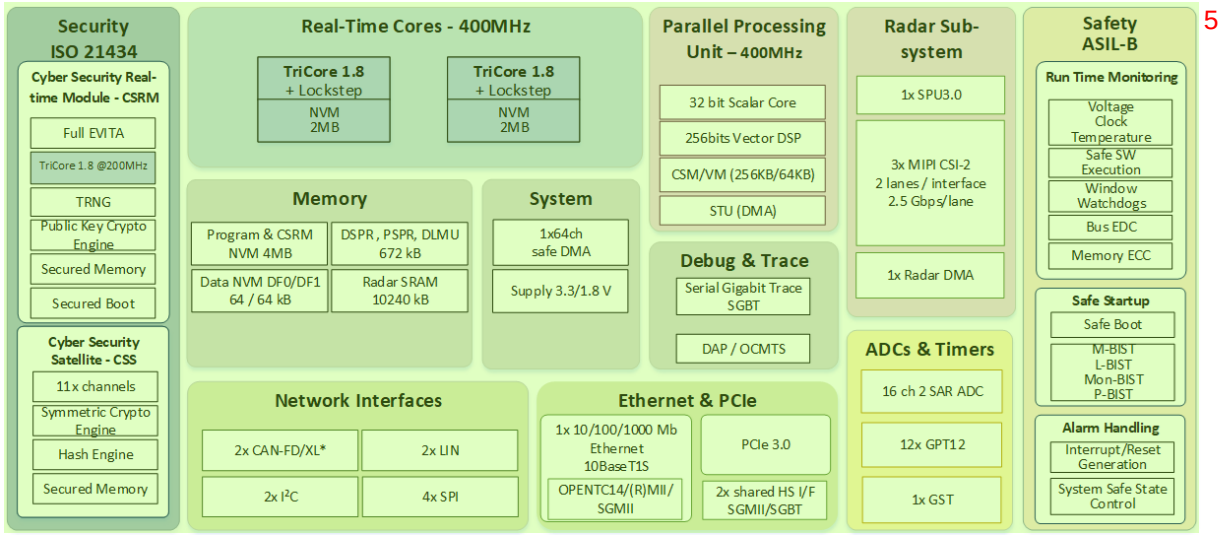
- **Parallel Processing Unit** (PPU) with **Scalar Core + SIMD Vector DSP** for **linear algebra acceleration** and post-processing
  - acceleration of **matrix** & **vector** operations with up to **77GOPS** + **800 DMIPs ASIL-B** for radar signal post processing functions

7

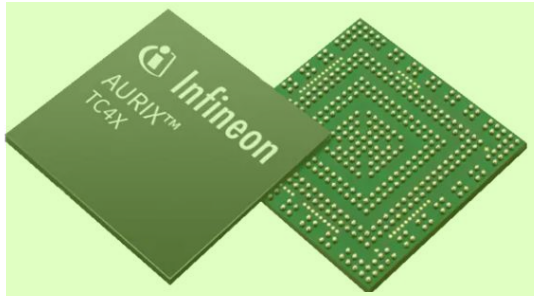
- **PCIe** enables cascading of **2xTC45** for higher channel Radar system
  - Achieve high performance **16x16** and **24x24** radar system using 2xTC45x

8

AURIX™ T45x 6



5



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From 8T8R to 24T24R and beyond
CTRX8191F + AURIX™ TC45: Powering imaging radars

1

2

Cost efficient 5

No RF substrates 6
No external memory
No external buffers

3

Performance 7

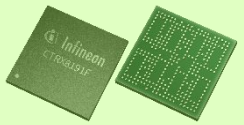
Better object separability 8
Higher resolution
Larger range/field-of-view

4

Scalability 9

Reuse software 10
Reuse hardware
Scalable systems

11

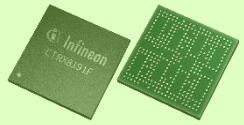


AFiP package

Large LO link budget (16dB)

Integrated NVM (4MB)

Integrated SRAM (10MB)



Fully flexible sequencer

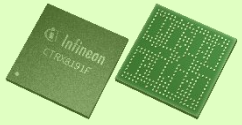
Fast flyback (1us)

Linearity (P1dB: -0.5dBm)

SPU3.0

PPU with vector DSP

Radar DMA

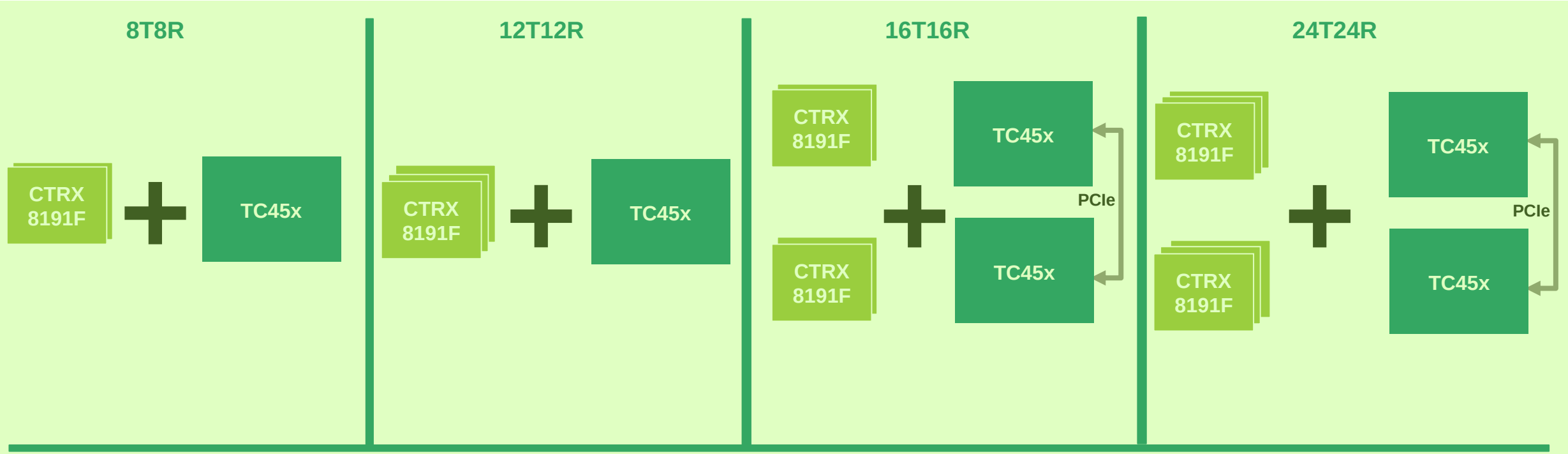


Cascading

Large LO link budget (16dB)

PCIe for combining 2x TC45

AURIX™ TC45x provides a cost effective and optimized feature set for cascading up to 6x CTRX8191F [1]



[2]

- 1x TC45x with **10MB Radar SRAM** is **optimized** for 8T8R and 12T12R use cases
- **Cascade 2x TC45x** using **PCIe** for 16T16R and 24T24R
- **2x TC45x** cascade will work over the specified **temperature range** i.e., -40° to 150°C

[3]

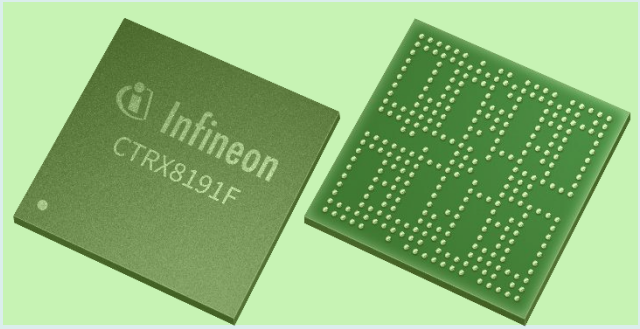
- Using **2x TC45x** provides combined **20MB SRAM, 2x SPU3.0, 2x PPU** for more processing performance
- **PCIe** makes **shared SRAM** between cascaded controllers **transparent.**

[4]

Speed up development time
Infineon offers multiple ways to evaluate CTRX [1]

CTRX8191F samples [2]

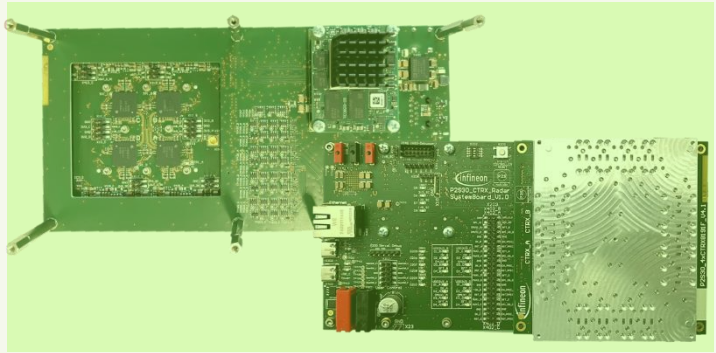
For module development [5]



[7]

CTRX P2S board [3]

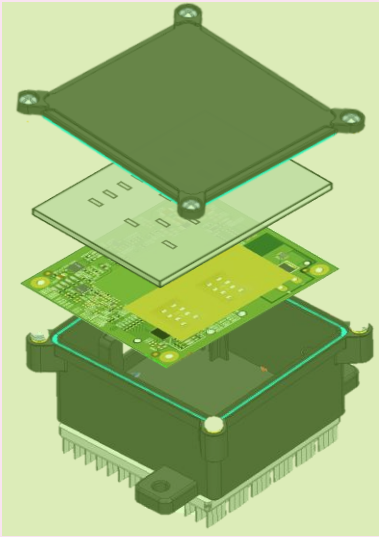
Full CTRX measurement capabilities [6]


[8]

– CTRX performance reference [11]

CARKIT [4]

Full module for initial data collection & accelerating module development [9]


[10]

– Reference design with schematics, layout, BOM, etc [12]

Infineon = trusted partner for 77GHz automotive Radar [1]

QUALITY LEADER [3]

[2]

Zero Defect is part of our DNA. Infineons products are designed with **reliability** and **manufacturability** in mind → ensuring high product quality at lowest dpm level resulting in **reliable radar sensors.** [4]

PERFORMANCE FIT [6]

[5]

Infineon offering **longest range, widest field-of-view, and most robust radar sensors** thanks to best-in-class RF & compute performance. [7]

BROAD PORTFOLIO [9]

[8]

Infineon covers all radar sensor segments – from standard NCAP radar sensor to Base Corner to High resolution radars - **and across all architectures** – from Full-processing to Pre-processing to Raw-data streaming [10]

MOST EXPERIENCED [12]

[11]

Infineon is the industry's radar gold standard for 77GHz: **More than 15 years of Radar experience with >300Mpcs RASIC™ MMICs and >200Mpcs AURIX™ micro-controllers on the road.** [13]


Infineon