# Designing embedded systems: from DSP to ARM architecture

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LEONARDO
SECURITY & INFORMATION SYSTEMS

# Security & Information Systems Division

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| Control Rooms, Platforms & Sensors | Analysis & Intelligence | Vessel Traffic Control | Packet & Parcel Handling |
| Transportation Solutions | Secure ICT Infrastructures | Border Control | Baggage Handling |
| | Government & Enterprise secure digital platform | | |

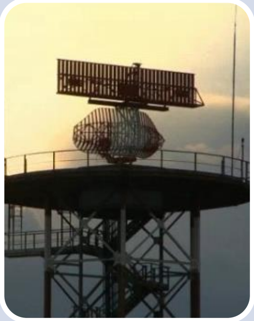
# Where we work

PMR represent a complex field radio communications system with mobile, base station and dispatch console radios. PMR radio are based on ETSI standards like TETRA. Key features of these systems are large coverage areas, closed user groups, point to multipoint comms, etc

DMR is an open telecommunication standard defined by ETSI TS 102 361 and used in commercial products with the goal of specify a digital system with low cost, low complexity and interoperability

The New Generation On-Board Unit (NG-OBU) is a versatile integration platform for Automatic Vehicle Monitoring and Fleet Management, Communication, Ticketing and Secure Videosurveillance for in-vehicle applications. The Unit provides an interface between the communication node, the operation centre, and any on-board devices

OTE ARES (Air-ground Radio Equipment for Single-sky) and OTE DEMETRA (Defense Multirole Transponder) are the 5th generation of the OTE VHF and UHF radio equipment family for ground-to air civil and air defense communications



ATCR-33S is an S-band system. It provides superior air traffic surveillance on terminal area. ATCR-44S is an L-band Air Traffic Control Radar. It provides superior surveillance on long-range-range and en-route applications. ATCR-SSR Secondary Surveillance Radar, designed for the detection of cooperative targets in surveillance services. Transmitters of these systems use solid-state technology (19-32 KWp) based on GaAs/GaN

AeroMACS

AEROMACS is a modern telecommunication system based on the commercial 4G WiMAX (IEEE 802.16) standard. It is designed for and operating in the aeronautical C-band (5 GHz) for short-range and high data rate communications.

# Signal Processing requests – why DSP were born

Very computationally demanding

Requires attention to numeric fidelity

High memory bandwidth requirements

Real-time constraints

Standards: algorithms, interfaces

# DSP vs ARM – software architecture comparison

| | DSP | ARM |
|---|---|---|
| **Operating System** | Proprietary (TI SYSBIOS, NXP,…) | Embedded Linux |
| **Multicore Architecture** | AMP (Asymmetric multiprocessing)<br>Developer responsability<br>Cache Coherency issues | SMP (Symmetric Multiprocessing) |
| **Real Time** | RTOS Pre-emptive Multitasking | Not garanteed<br>- PREEMPT_RT (bounded latency with single kernel solution)<br>- Xenomai (fast and deterministinc response to interrupt based on dual kernel architecture)<br>- Real Time algorithm at kernel space |
| **Multicore Debugging** | Single Core debugging<br>Easier access to the device | Application Level |
| **Portability** | Low<br>- High performance reached throught proprietary compiler directive of assembler instruction | Fully portable<br>POSIX |

# DSP extentions for ARM

FPU

- Half Precision
- Single Precision
- Double Precision

NEON Technology

SIMD Architecture

- 16x8-bit, 8x16-bit, 4x32-bit, 2x64-bit integer operations
- 8x16-bit, 4x32-bit, 2x64-bit floating-point operations
- NE10 Library
  - Math Functions (Vector, DOTP,…)
  - Complex/Real FFT
  - FIR Filters, Decimation, Interpolation, Lattice
  - IIR Lattice Filters
  - Matrix Multiply

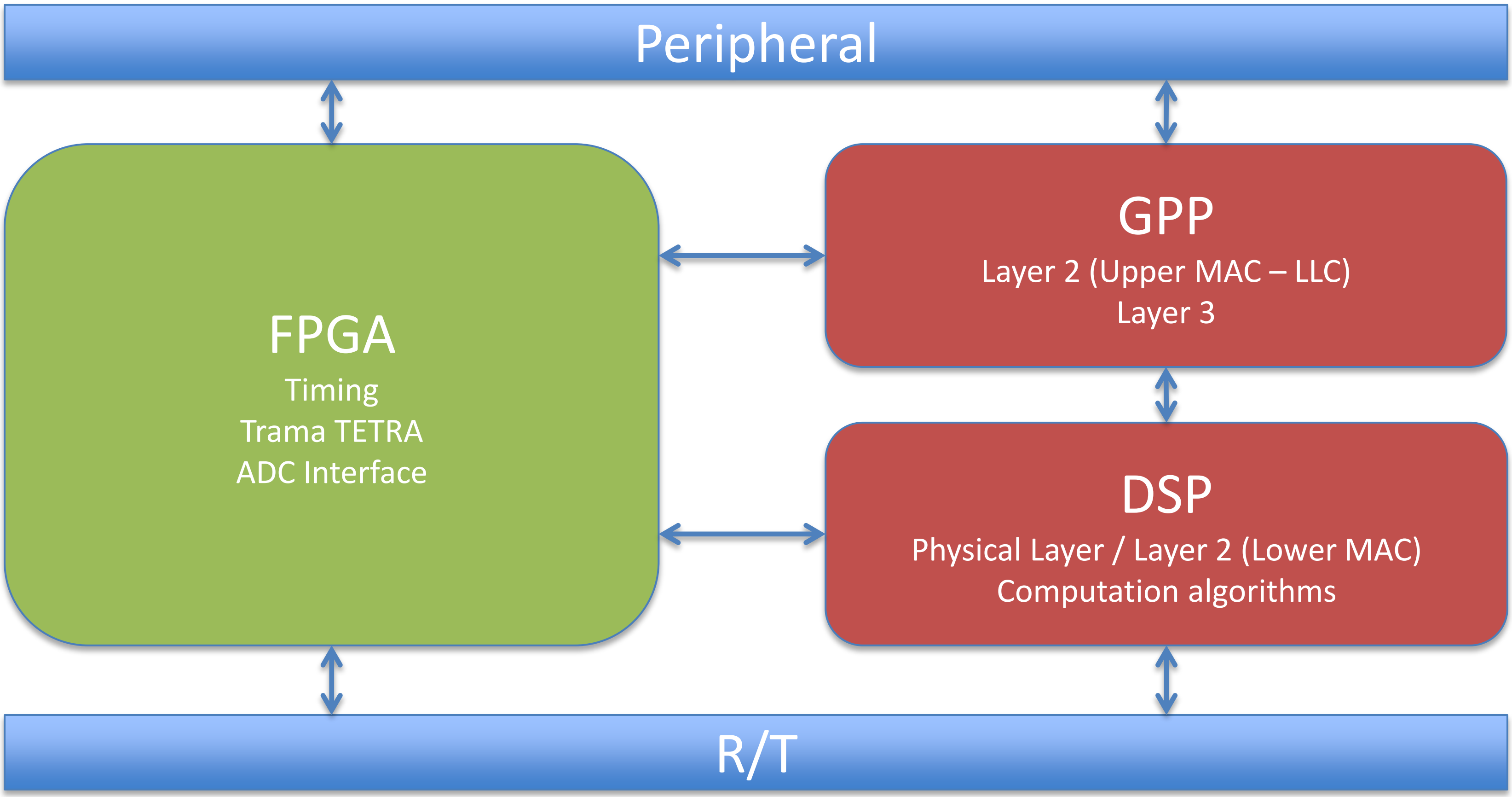
# From DSP to ARM architecture: main porting issues

- DSP generally use different access approach to HW resources so Programs must be aligned to a different Low Level Driver usage
- Passing from a Proprietary OS to Linux Embedded all Processes, Tasks and State Machines must be restructured
- Linux Embedded isn't strictly real-time so all algorithms which needs to reach some time constrain performace must be modified considering new architecture behavior
- All HW depended intrinsic code and Assembler must be rewritten in standard C  making the most of the new architecture to reach same or better performance

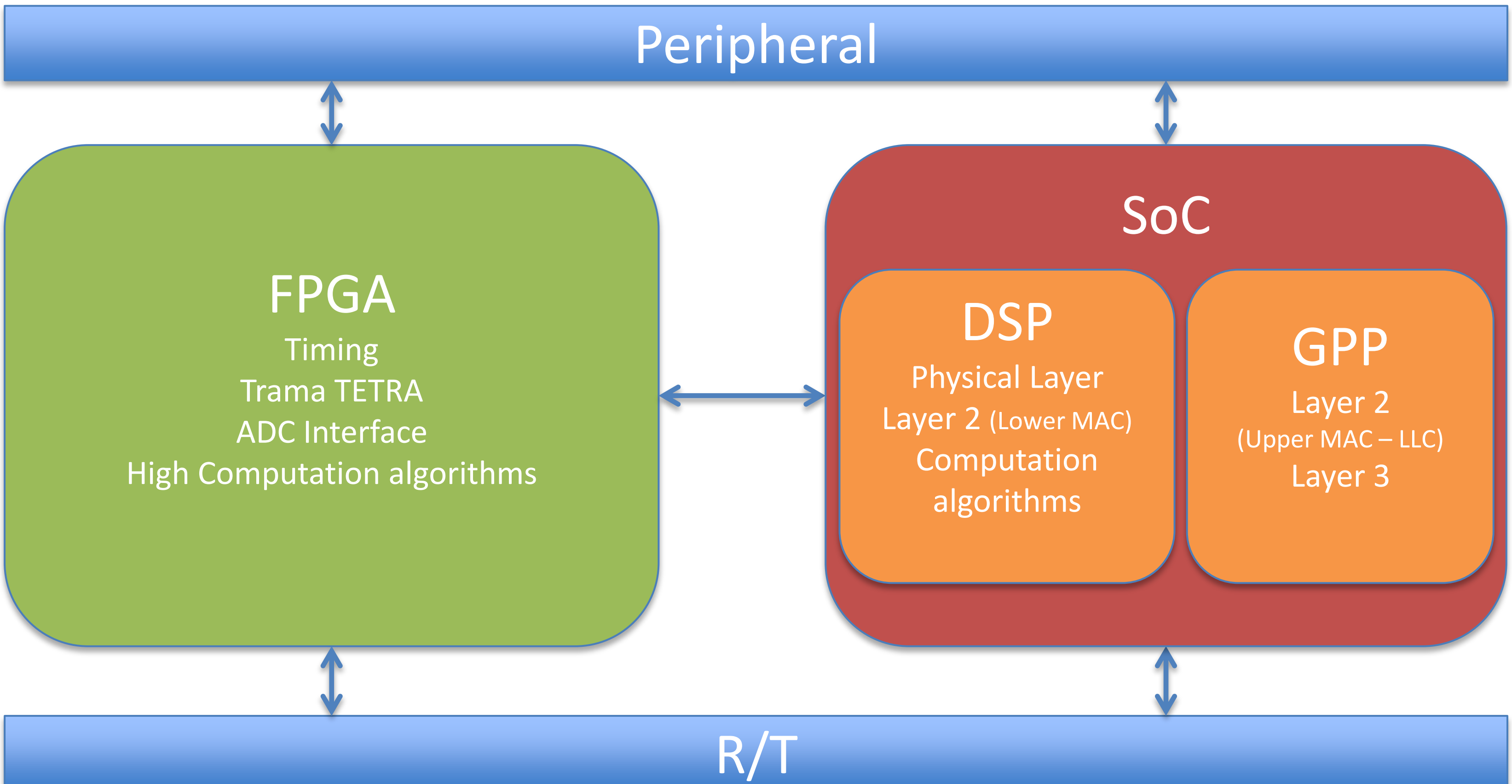
# DSP (C64x+) and ARM (Cortex-A9/ARMv7) compared

| | DSP 660MHz | ARM 1GHz |
|---|---|---|
| Interpolator FIR (Uplink TETRA) | 370us | 230us |
| Source Coder (TETRA) | 3.9ms (with intrinsic) | 6ms |
| Downlink Processing (VPD TETRA) | 800us | 250us |
| Uplink Processing (64QAM 2/3 50kHz TEDS) | 2.1ms (with intrinsic) | 2.4ms |

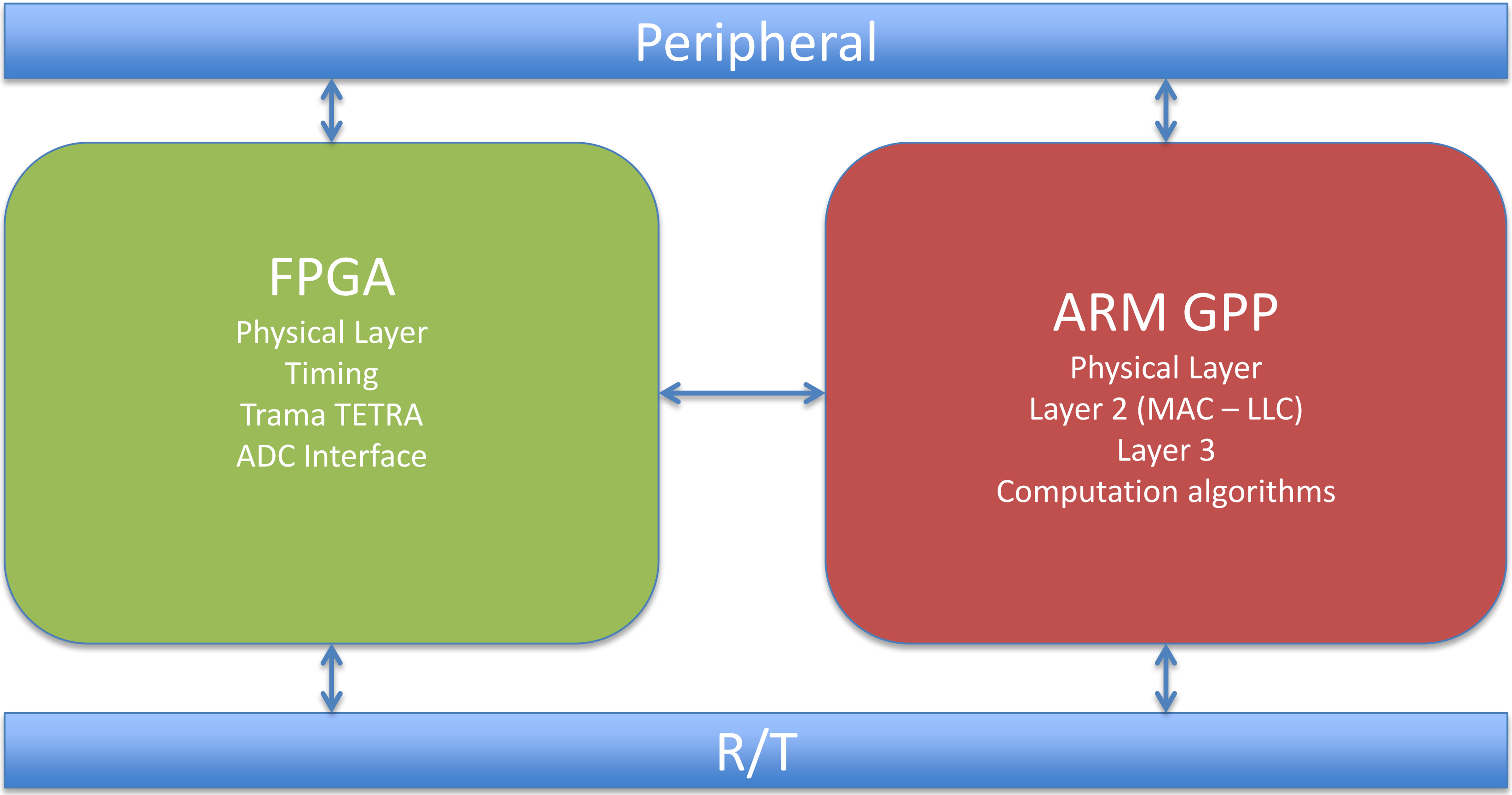
# PMR Architecture – in the past…



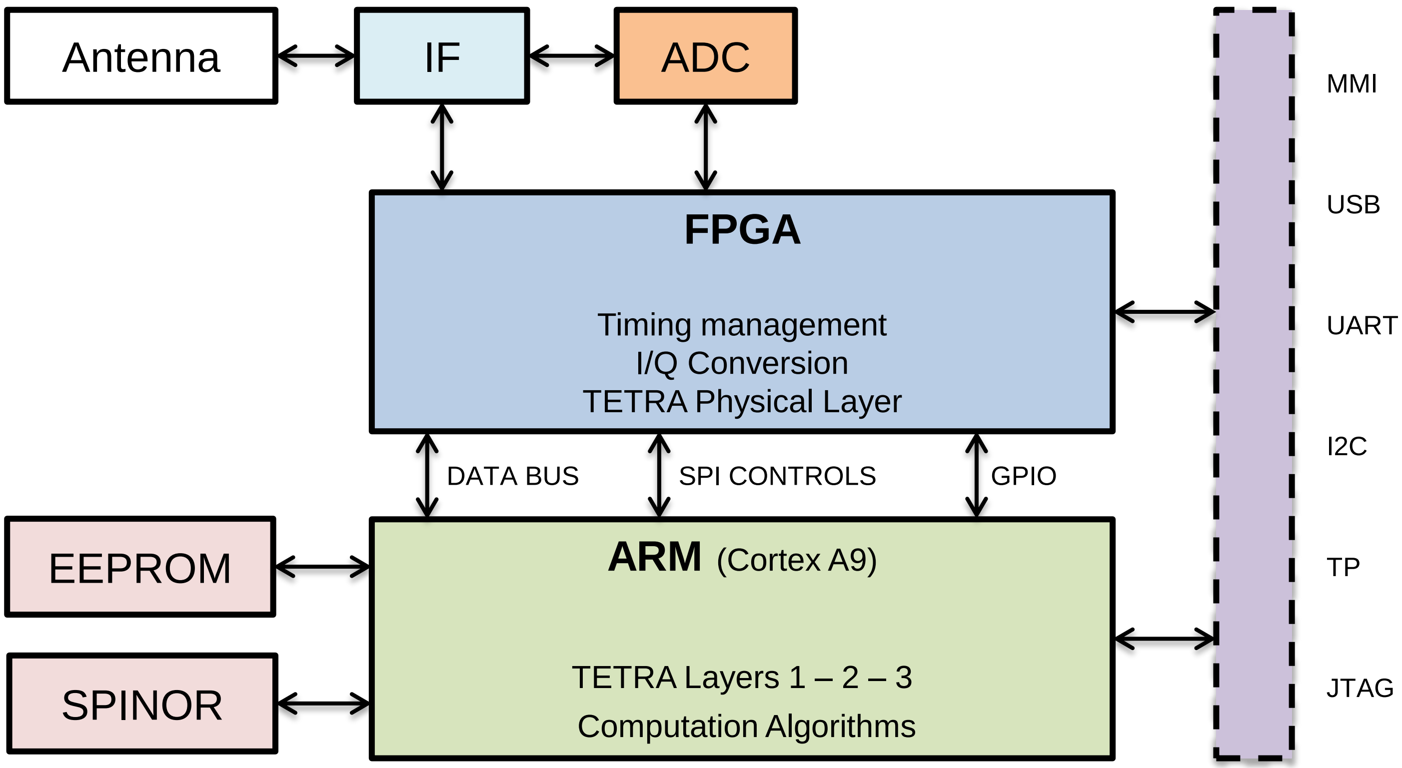
# PMR Architecture – where we were…



# PMR Architecture – where we are…



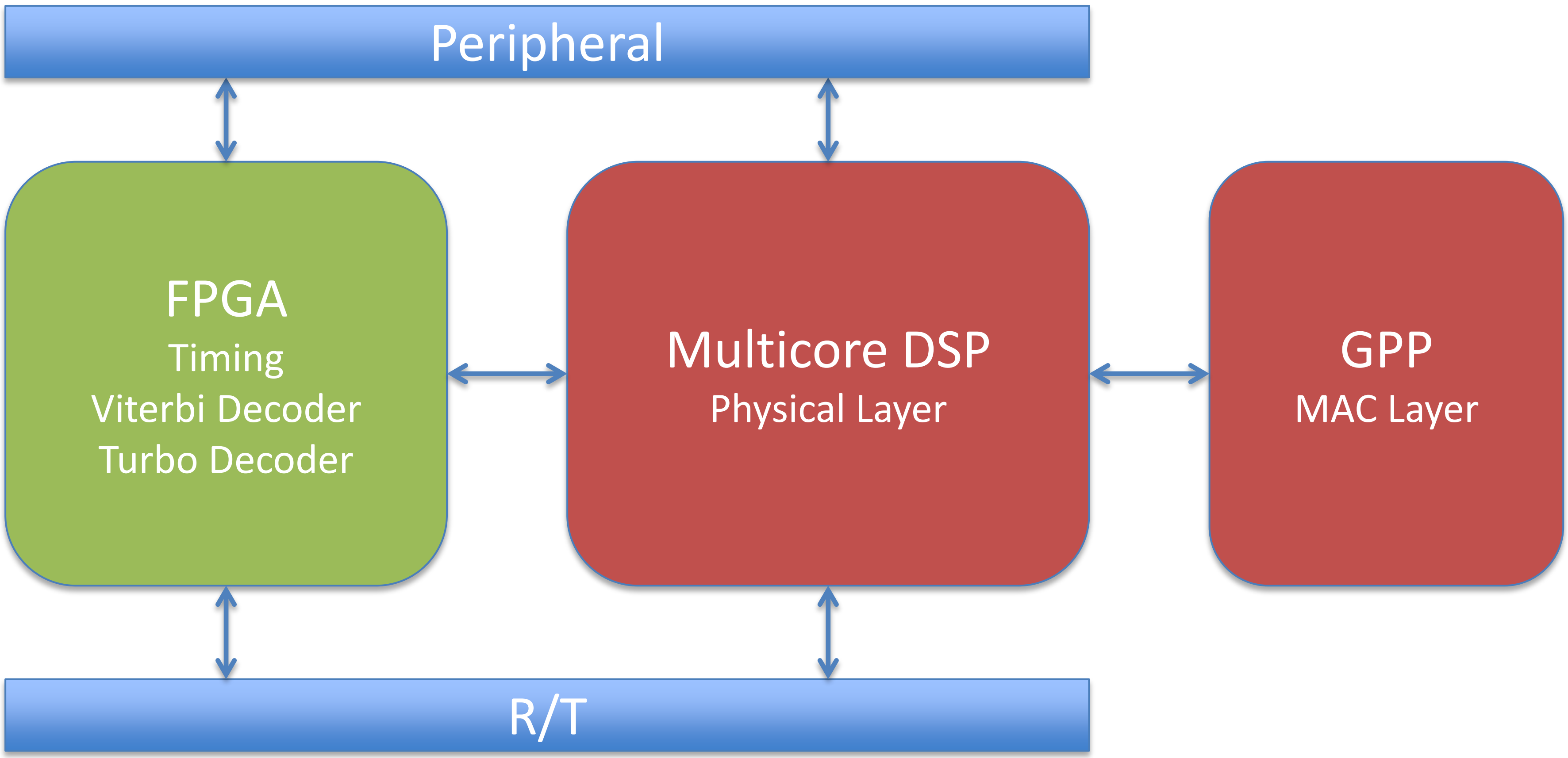
# PMR Architecture – example of our Modem Tetra boards



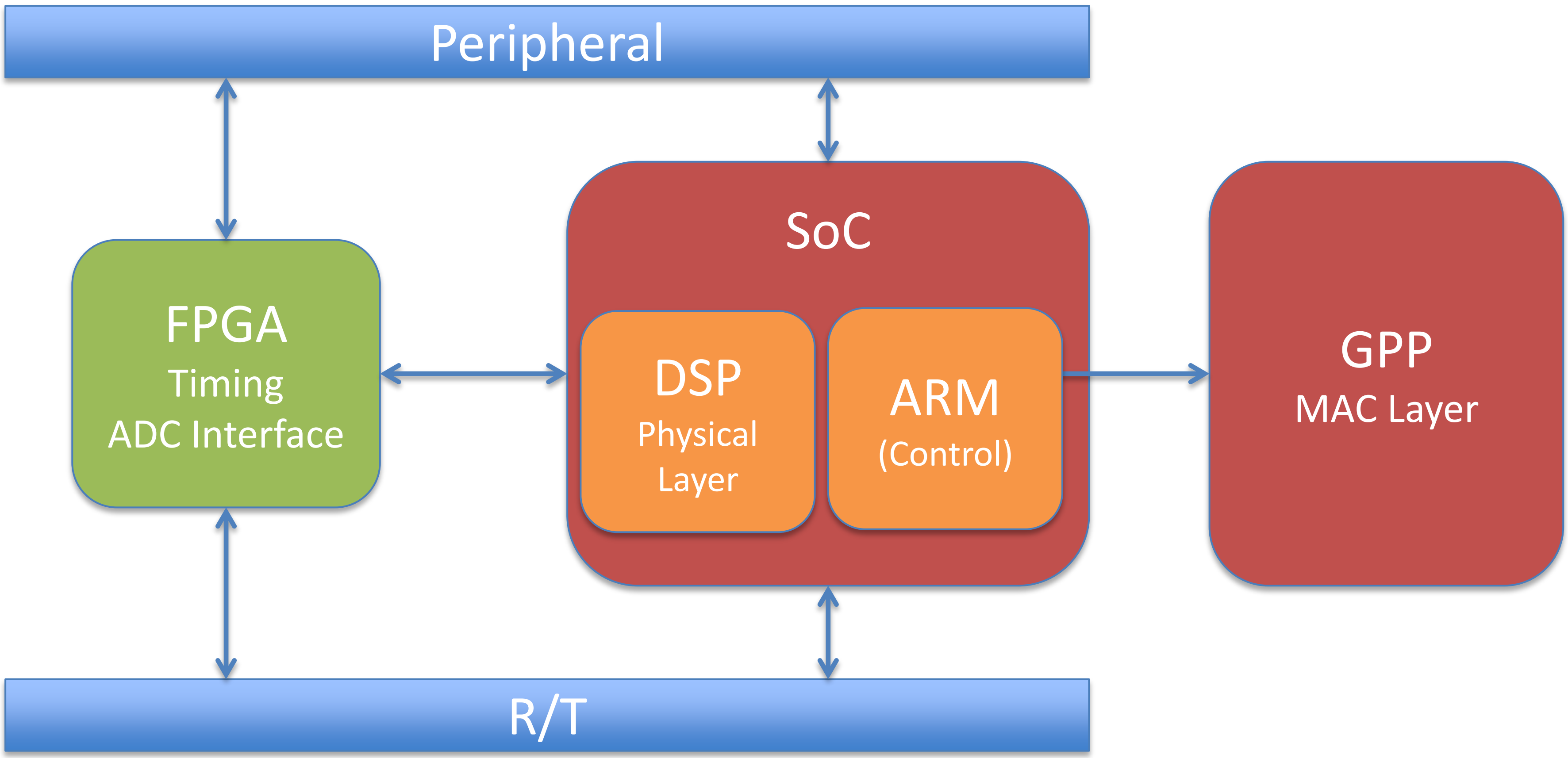
## T4 Modem board


## VS4000 board

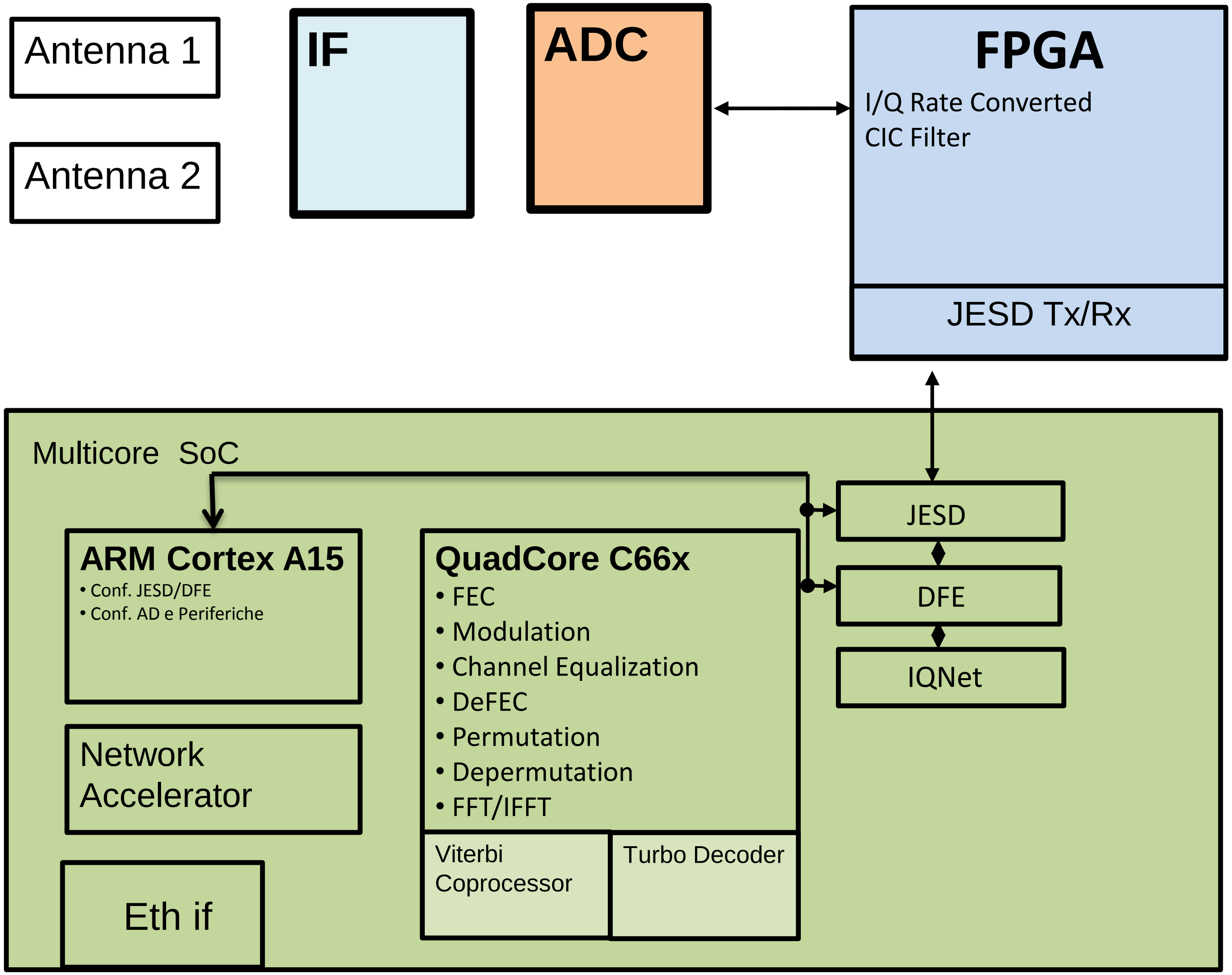
# OFDMA Architecture – where we were…



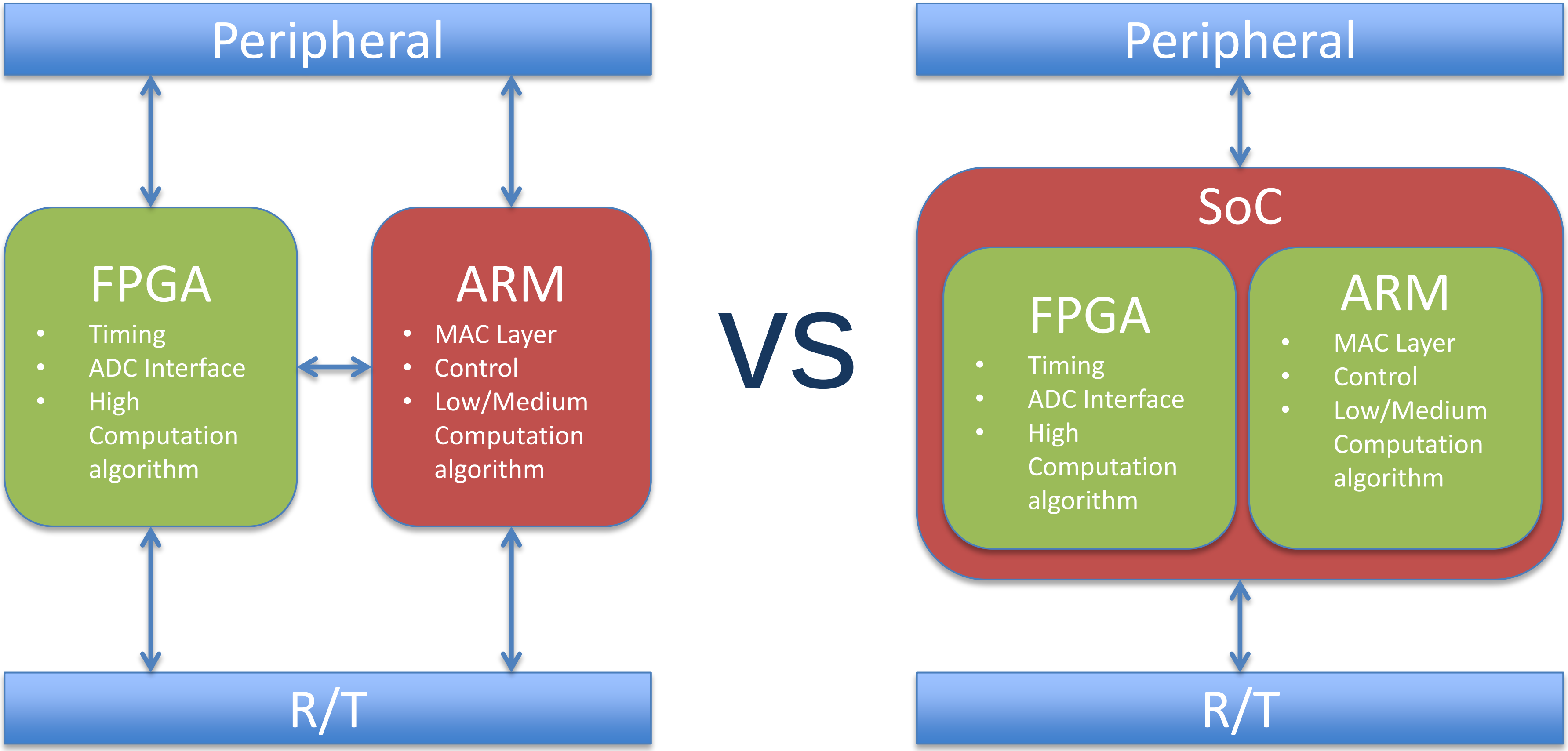
# OFDMA Architecture – where we are…



# OFDMA Architecture – details



# Future Architecture – where we are going…



# ARM vs DSP advantages conclusion

- Software porting to open platform
- Low Power Consumption
- Low Cost and extended End of Life
- Standard Compiler
- Spread skills requested
- Community support
- Medium / Low Algorithm in ARM
- High performance Algorithm in FPGA

THANK **YOU** FOR YOUR ATTENTION

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