Multi-Standard Processing using DAB and 802.11p

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1. Introduction

Situation

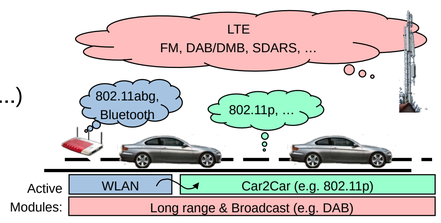
- **Increasing number** of wireless standards for mobile environment requires new design approach for electronic control units (ECU)
- Multiple wireless standards must run in **parallel**

Approach

- Software Radio provides flexibility for upgrades and configurations

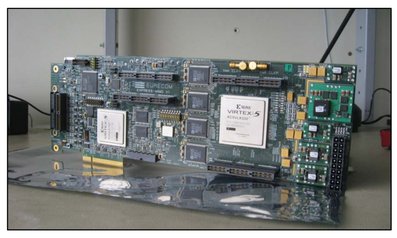
Challenge

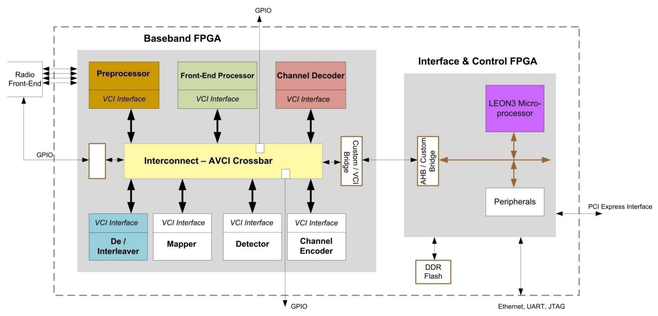
- SDR Platform is **MPSoC system** with accelerators for special operations (Vector Operations, FFT, Channel Decoder, ...)
- **PROTON/PLATA Project: Parallel processing** of ETSI-DAB and IEEE-802.11p by sharing the same hardware resources
- **Time-sharing between multiple standards** while meeting latency and processing requirements



2. OpenAirInterface – ExpressMIMO Card

- The **OpenAirInterface Platform** is a generic prototype architecture for multimodal applications
- **Support of a high number of different standards**: 3GPP, UMTS (TDD), WLAN 802.11a/g/p, WIMAX, GSM, DAB, LTE, …
- **Advantages** include effective use of the spectrum, mobility, increased network capacity, maintenance of cost reduction, faster deployment of new standards, improvement of existing standards and faster development of new services
- **Baseband processing** operations are split over independent IP Blocks that are controlled by a LEON3 microcontroller

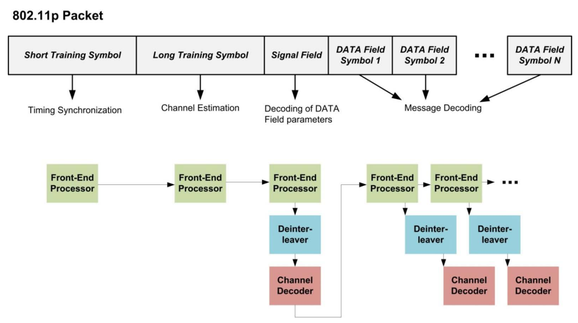




3. 802.11p vs DAB

Properties 802.11p receiver

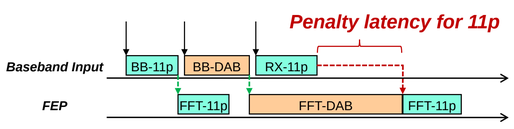
- Packet oriented standard
- Between 480 and 109680 samples per packet (correspond to 48us to 10968us for 10MHz channel spacing); number of samples depends on the modulation scheme
- Processing Time of one packets depends on packet size, modulation scheme , interarrival time
- Strong latency requirements



Challenges

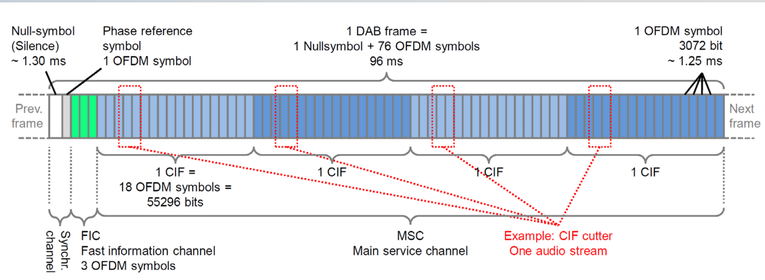
- Communication System: Short latency requirements (microseconds) must be satisfied
- Broadcast receiver: Large symbols and vectors cause long execution time
- Macro Operations (FFT, Vector Operations, Interleaver, …) cannot be interrupted

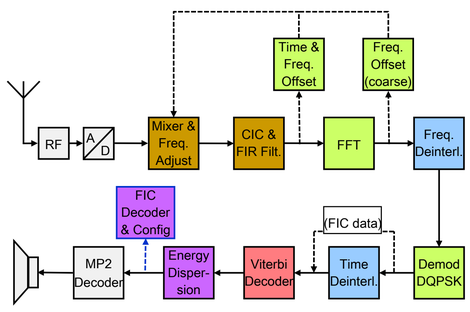
➔ **Sophisticated timing-aware scheduling is required**



Properties ETSI-DAB receiver (Digital Audio Broadcast)

- Bandwidth: 1,536 MHz
- 2048-OFDM + D-QPSK
- OFDM symbol duration: 1ms
  DAB frame duration: 96ms
- Continuous data stream
- Deterministic timing & processing

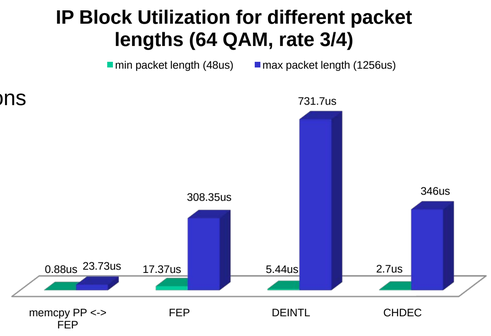


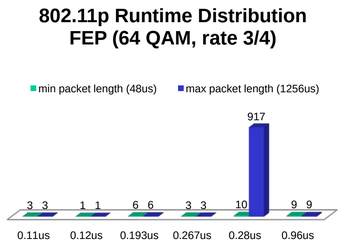


4. Timing Analysis

IEEE 802.11p

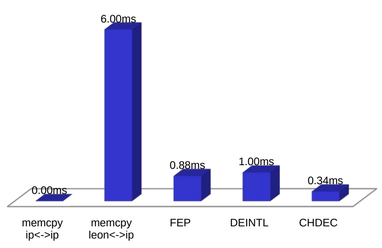
- FEP Macro execution time varies from 0.11us to 0.96us
- Due to strong latency requirements, grouping of Vector Operations in the Front-End Processor (FEP) recommended
  → less time-consuming memcopy required
- The processing times for the IP Blocks include the memory transfer times as the IP Blocks are not available for DAB operations during this time

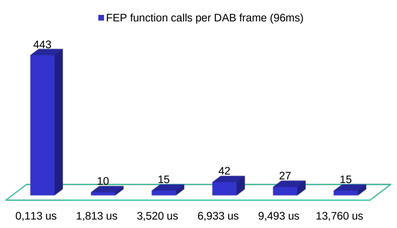




ETSI-DAB

- FEP Macro execution time varies from 0.14us to 13us
- Longest functions are vector operations; they can be split arbitrarily
- Currently: save context after each macro operation
  → time-consuming memcopy required
- FFT (9.49us) cannot be easily split





5. Conclusions and Future Work

Conclusions

- Latency requirements fulfilled if only one standard is processed
- Critical processing block: Front-End Processor (FFT cannot be split easily)
- Scheduling algorithm has to consider
  - The strong latency requirements of 802.11p
  - That each splitting of operations requires additional processing time for context saving

Future Work

- Investigation in a timing-aware dynamic scheduler to solve latency problem
- Dynamic splitting of long vector operations into several shorter operations