ORCA-PROJECT.EU

LOW LATENCY INDUSTRIAL COMMUNICATION

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ORCHESTRATION AND RECONFIGURATION CONTROL ARCHITECTURE

Outline

- Motivation
- ORCA targets
- What ORCA offers
- Low-latency networking showcase
- A case study with ORCA facilities

Industrial Low Latency Communication

Motivation:

- Collaborative robots in industry
- Cloud-based applications
- Bandwidth intensive applications

Low-latency and reliable communication

Motivation:

MAC & network layer testing

PHY (and MAC) are fixed in chip

Physical layer testing

Very **flexible** PHY testing possible
Not real-time

ORCA enables flexible, real-time PHY, MAC and network layer tests

ORCA Targets

- Reconfigurable SDRs
- Low latency end-to-end networking
- SDR for short Round Trip Time

What ORCA offers

- Open MAC/PHY for ORCA experimenters
- Modular and Cross-layer MAC-PHY architecture
  - Scalability
  - Easy development
- MAC as close to PHY as possible
  - Low latency
- Run-time programmable MAC
  - Flexibility

ORCA Showcase Overview

Ethernet

Control unit

Sends synchronized command to all the networks

Non-homogeneous wireless network

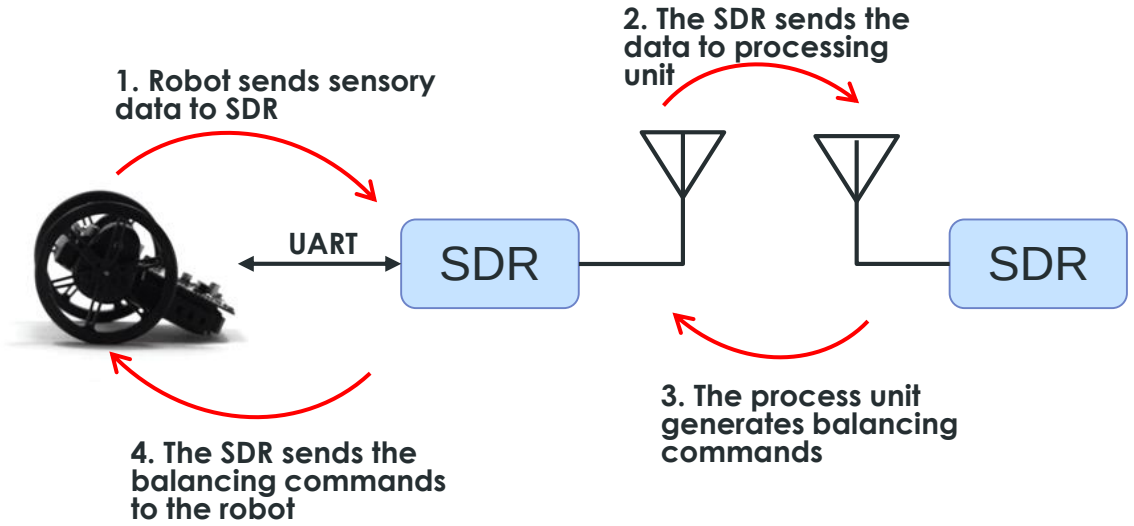
IEEE 802.15.4 TDMA (IMEC)

GFDM PHY, FDMA MAC (TUD)

IEEE 802.15.4 CSMA/CA (KUL)

ORCA Showcase Overview

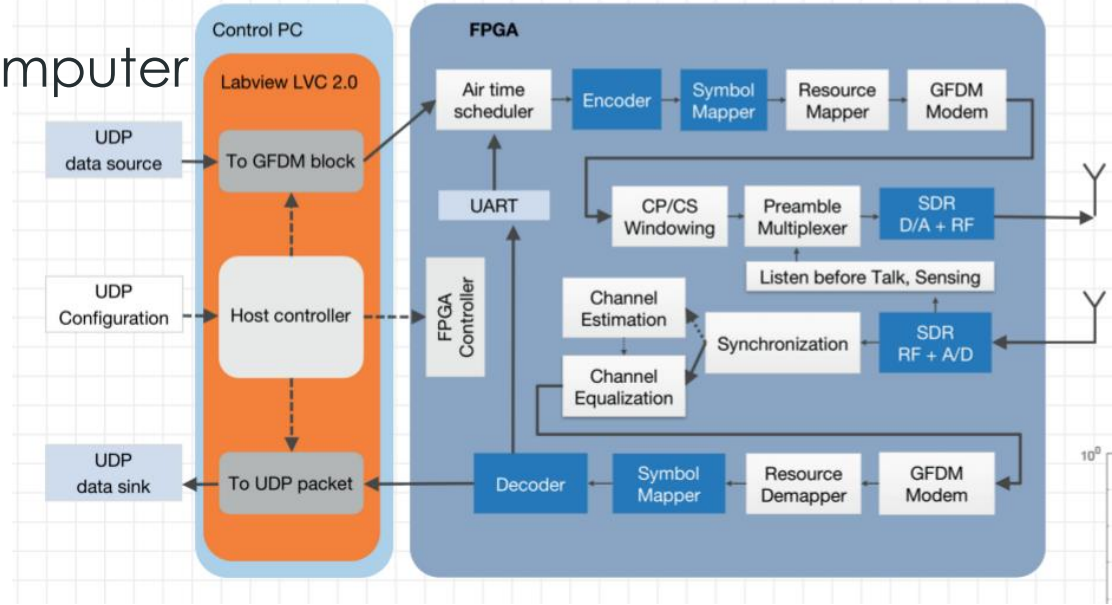
Balancing needs low-latency link



ORCA Showcase; MAC and PHY

Flexible GFDM

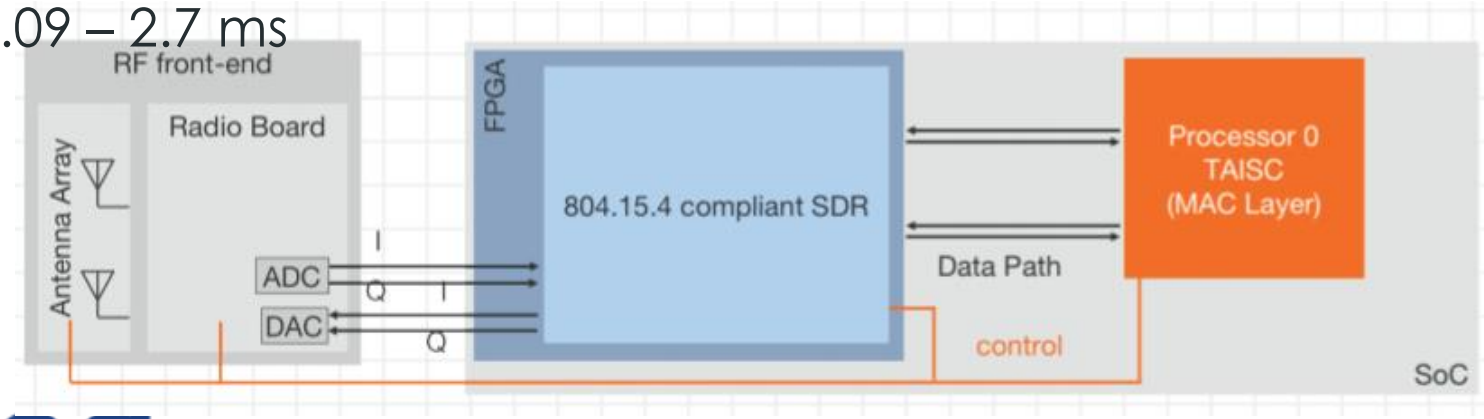
- PHY and low-level MAC on FPGA
- High-level MAC on host computer
- RTT 1.5 ms



ORCA Showcase; MAC and PHY

Low Cost Flexible and Integrated MAC and PHY

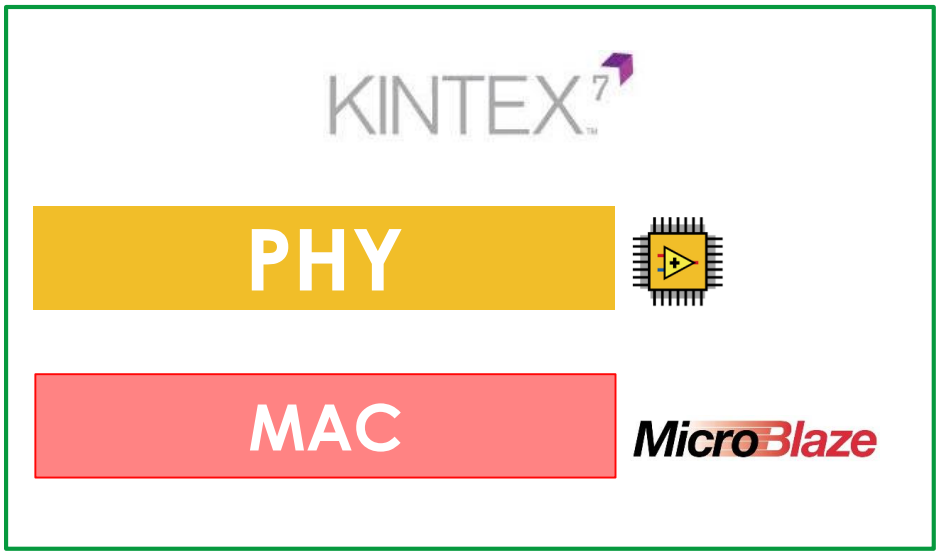
- 802.15.4 PHY on FPGA
- MAC on TAISC processor
- RTT 1.09 – 2.7 ms



ORCA Showcase; MAC and PHY

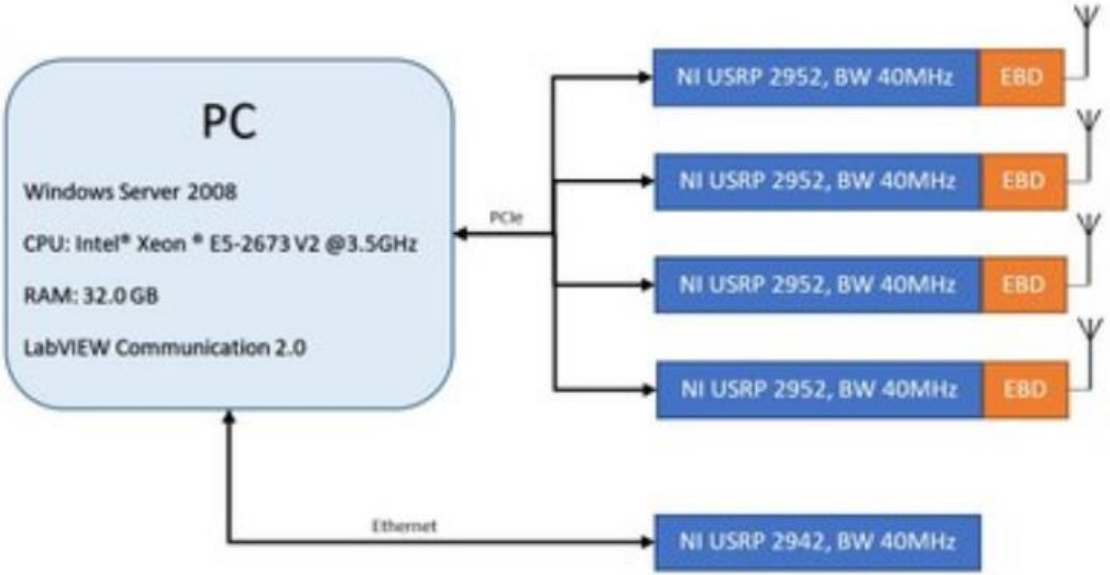
Cross-layer PHY/MAC Architecture

- 802.15.4 PHY on FPGA
- MAC on Micro blaze softcore
- RTT 1 – 1.51 ms

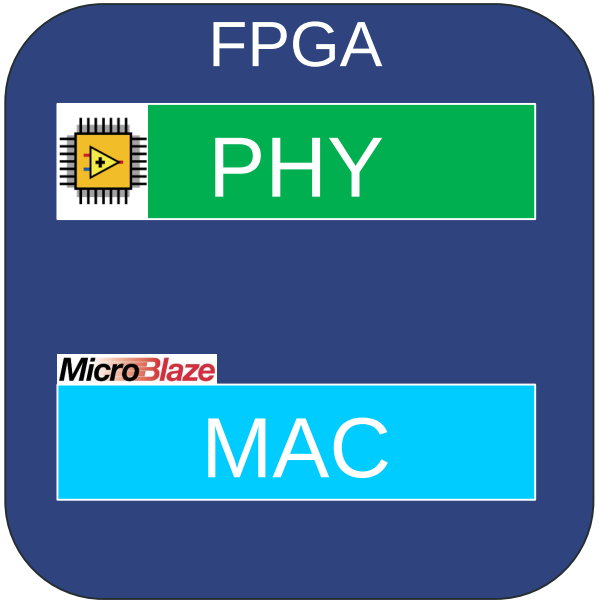


ORCA facilities for system level experimentation

KUL testbed



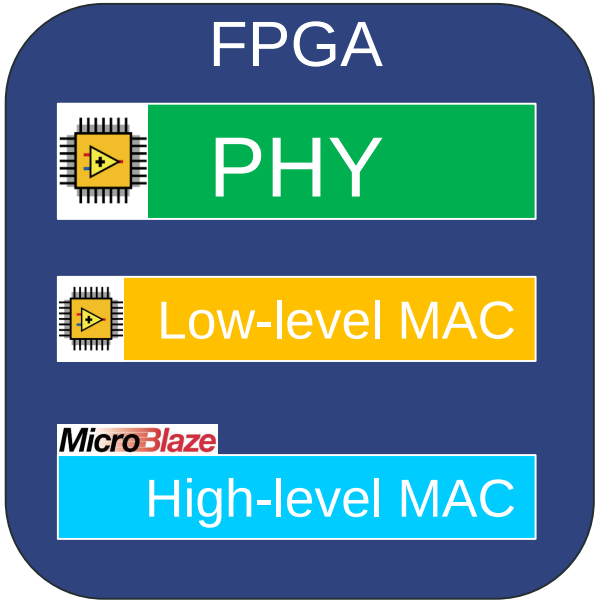
Low-latency Network for Cloud-based Robot Control

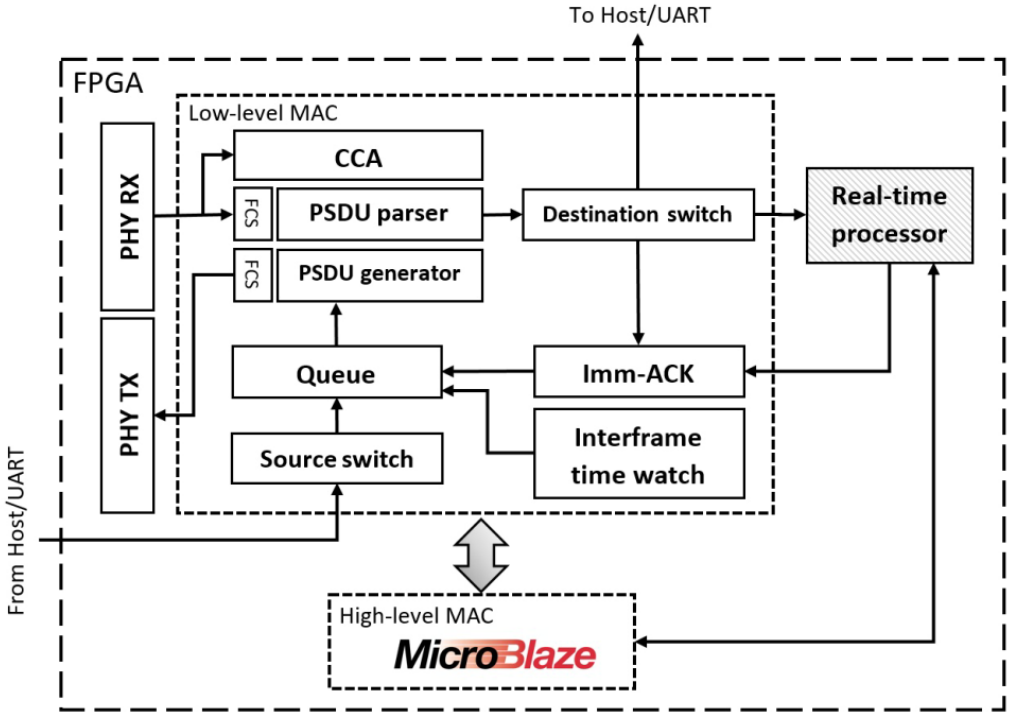


- Pipeline processing
- Heavy data-flow

- Complex control
- Multi-stage procedures
- Interrupt handling
- Flexibility

Low-latency Network for Cloud-based Robot Control

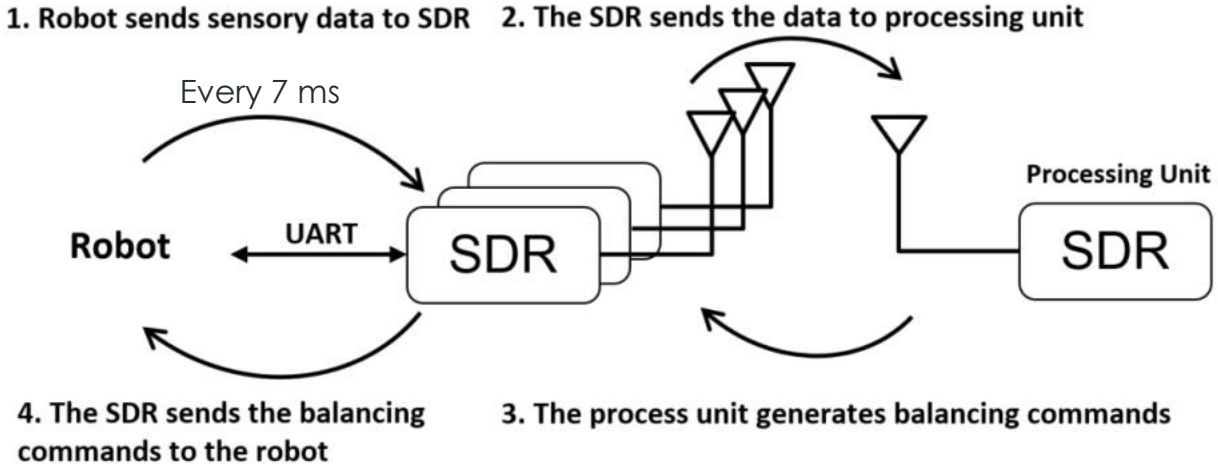


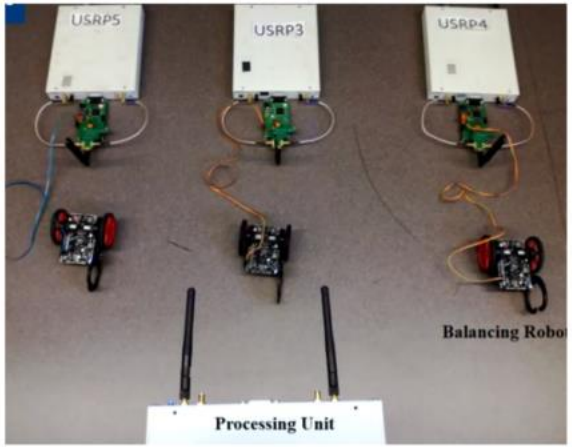


Low-latency Network for Cloud-based Robot Control

- High level MAC
  - Backoff time handler
  - Determining Source/Destination
- Low-Level MAC
  - Generating and parsing PHY packet
  - Generating and parsing frame check sequence
  - Interframe time watch

Low-latency Network for Cloud-based Robot Control





- Sensor update interval 7 ms
- Unslotted CSMA to share the channel (2.4 GHz)
- Imm-Ack packet to transmit balancing commands

Low-latency Network for Cloud-based Robot Control

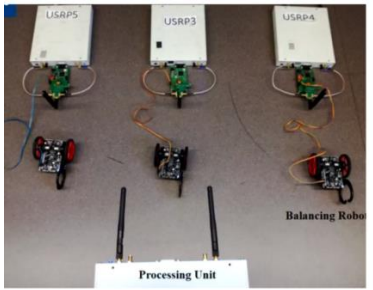
	MicroBlaze	+ MicroBlaze
	One layer MAC	Tow-layer MAC
Time to generate ACK packet and pass it to the packet queue	10-16 µs	0.41 µs
FPGA Resource consumption	8%	< (8+2)%
Packet loss rate (4 nodes)	3.5%	< 0.4%

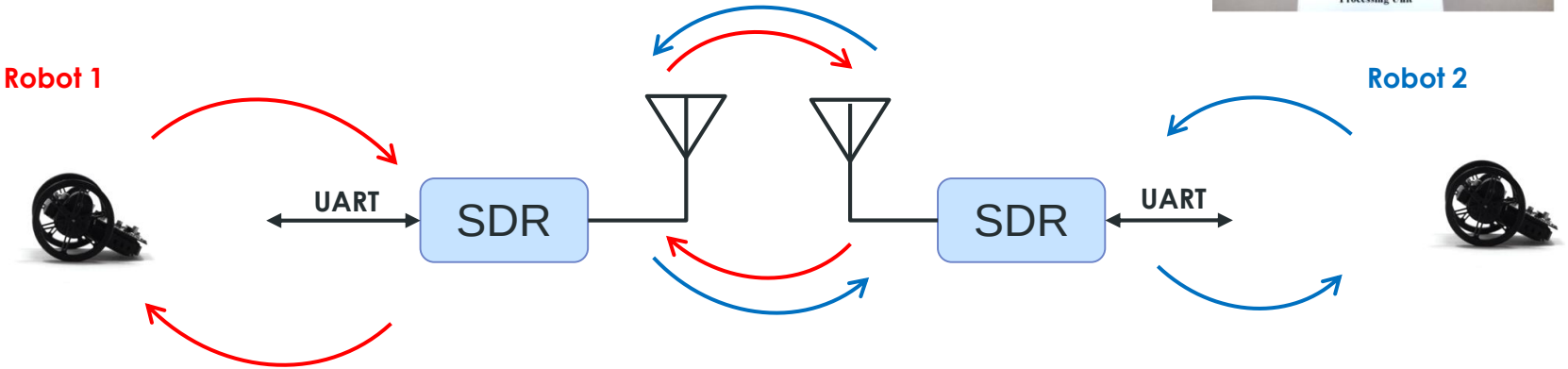
- Reliability + latency improvement
- Scalable low-level MAC
  - Multi-channel & full-duplex MAC schemes

Demo in CROWNCOM

Low latency communication over a single band;

- **Two robots and 4 radio links**
- **Contention-based network ; unslotted CSMA/CA**





Thank you for your attentions!

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Questions!?