

## E3DA Research Unit @ FBK – ICT Center

The **Energy Efficient Embedded Digital Architectures (E3DA)** Unit at Fondazione Bruno Kessler (FBK ICT Center) has expertise in energy efficient Wireless Embedded Systems. The activity spans from hardware-software development for low-power wireless smart sensing devices and energy efficient digital architectures to power management techniques, low power multi-hop wireless protocols and on-board processing in resource-limited devices.

Research focuses on:

- **Energy Efficient Wireless Embedded Systems hardware and software development**
- **IoT, Wearable Computing and Body Sensors and Actuators Networks**
- **Application in environmental monitoring, Smart Cities, Smart Retail, motor rehabilitation, physiological monitoring, human-computer interaction**

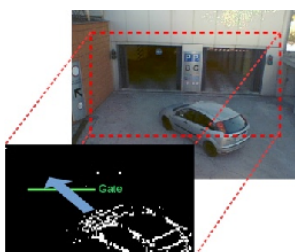
### Projects and Technologies



**SMART MOBILITY.** The **CLIMB** project aims at promoting the **independent mobility of children** with the help of **IoT** tools such as **wearable** sensors, app, **gamification** techniques and cloud services. We have a smart community approach involving children, parents and schools and public institutions (i.e. Trento municipality). We support the walking bus practice with our **Pedibus 2.0** and promote education to independent mobility at school through **Kids Go Green** game. We have equipped La Vela, a neighborhood in Trento, with sensors to create a **Smart City Living Lab**.

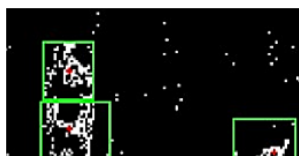


**SMART GARBAGE COLLECTION –** The project **Make It PAYT: Pay As You Throw** provides an integrated HW/SW platform for the certified identification of waste containers and when they are emptied. We use embedded technologies (i) to identify when to turn on the antennas; (ii) sensors to detect when truck stops and the operator is behind it (inertial, PIR, IR array) and (iii) certify a container has been emptied + something actually entered the truck through use of ToF and ultrasound sensors.



consuming microwatts to enable wireless applications for the IoT, in smart city and smart surveillance scenarios requiring computational power and mobility but at the same time energy efficiency.

**SMART VISION - Ultra-low power architectures for always-on vision nodes (TRL 3).** We work on low-power audio and visual sensors for embedded low-power distributed platforms. We cooperate with UNIBO and ETHZ to exploit low-power multi-cores platforms (i.e. programmable PULPv3 platform) in combination with FBK custom imagers



**WILDLIFE MONITORING** -: study animals in the wild, from their own point of view; study human impact, disease spread. **Activity**: test systems deployed on deer in Trentino and Canada and foxes in UK, Trentino bears (with LORA). Complex platform with radio, GPS, modem, environmental parameters. Application of novel proximity detection protocol and smart triggering of energy consuming sensors (e.g. GPS)

**Novel Communication Protocols** such as (1) **BLEnd – a BLE-based 1-hop contact detection** to efficiently monitor proximity of members of a group. It is designed to support a service level agreement and it is collisions aware, e.g., I want 95% of the detections within 2 seconds and I expect to have at most 50 nodes together at any given time. (2) **Crystal – a novel network stack for sparse and aperiodic data (e.g., events) in 802.15.4 networks**; transport protocol atop synchronous transmissions with minimal network overhead and timely and reliable data dissemination, also in the presence of interference (e.g. WiFi, microwave oven, etc.). (3) **Wake-Up Radio** – evaluation and new protocols; ultra low power radios, designed to be always-on and used to trigger higher power interactions; testbed for technology evaluation, novel protocols exploiting WuR.

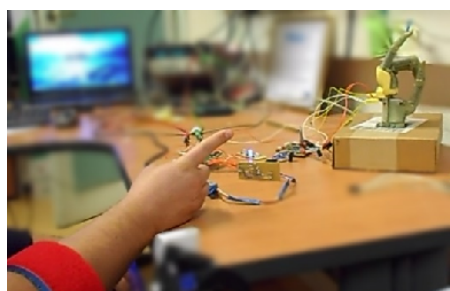


**SMART HEALTH and SPORT - Smart sensing technologies for sport equipment.** In cooperation with **Motorialab srl**, we supported **Salewa srl** to embed wireless communication and sensing capabilities in their equipments to augment user safety and enhance the sport experience (e.g. skiing).



**Riablo and Riablo@Home.** E3DA cooperates with **CoRehab Srl** to keep their products at the edge of motor rehabilitation technologies, functional

assessment in sport and recovery from injuries. In particular, we target their use at home, coping with the challenges of an uncontrolled environment and of possible non technology-expert users. We cooperate with our expertise in inertial sensing, sensor calibration, wireless communication, motion tracking and energy efficient embedded processing.



**Wearable EMG, EEG, ECG with smart AFE (TRL 3).**

We are expert in wearable embedded systems for physiological monitoring, working on both energy efficient and compact hardware with ETH and UNIBO and on board signal processing and machine learning. We are demonstrating the system with EMG for gesture interaction in prosthetics and HCI, embedding real-time processing and filtering, reaching performance comparable with high-end instruments. We are also working on early diagnosis of autism on newborn with EEG in cooperation with CIMEC neuroscientists.

**We work also on smart retail projects – visit our website for further information**

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