UNIMORE
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

Dipartimento di Scienze e Metodi dell'Ingegneria

Tecnopolo di Reggio Emilia

Centro Interdipartimentale Intermech MORE

RETE ALTA TECNOLOGIA EMILIA-ROMAGNA HIGH TECHNOLOGY NETWORK

IES Lab
Industrial Electronic Systems

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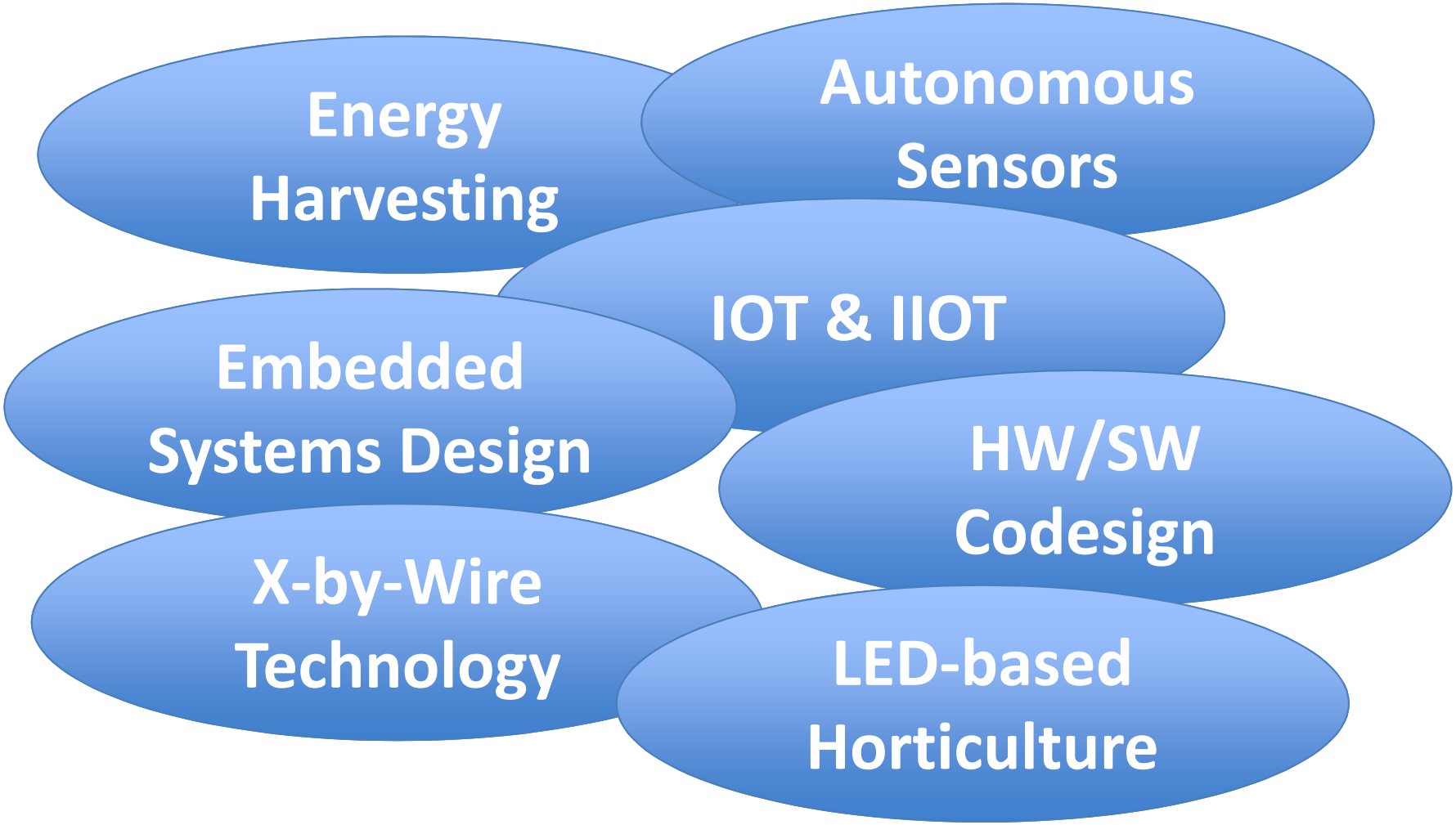
Keywords

IES
INDUSTRIAL ELECTRONIC SYSTEMS



Research Fields

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- Autonomous Wireless Sensor Nodes for Industrial Applications
- Energy Harvesting Systems for Ultra Low Power Applications
- Electronic Solutions for Automatic Machineries, Industrial & Off-Highway Vehicles, Automotive and Active Safety Enanchement
- Mechatronic Solutions & X-by-Wire Systems
- LED-based solutions for horticulture applications

Application Fields

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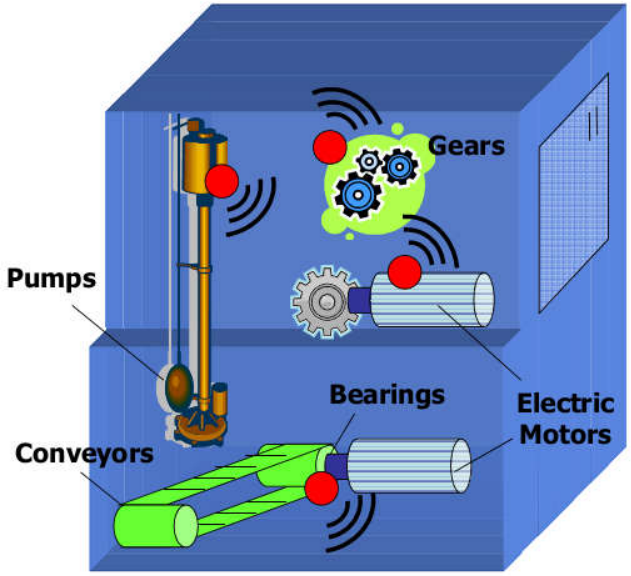
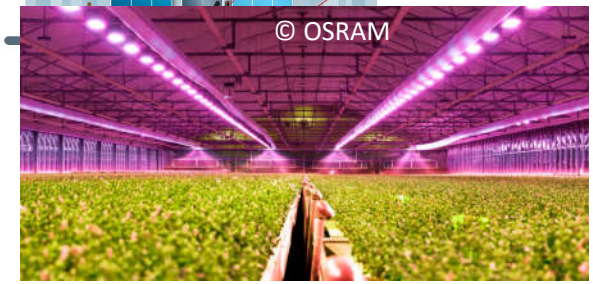
Machineries



Infrastructures



Final Products

Case Study 1
Safety on Off-Highway Vehicles

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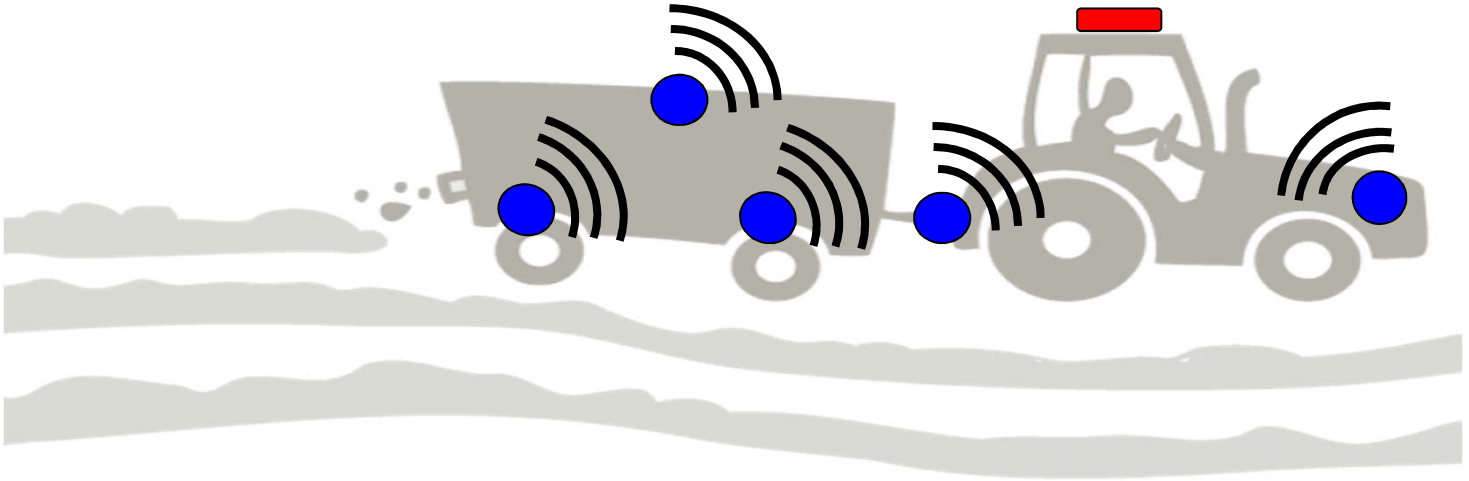
Master Device (1): data collection, data processing, gateway towards other ECUs

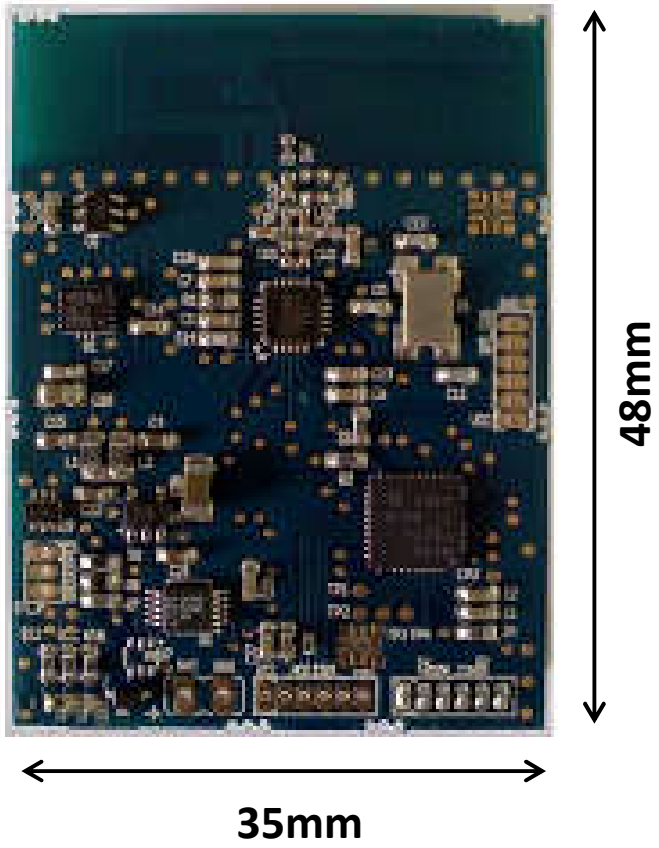
End Devices (many): data acquisition,
VIBester (Vibrational Energy Harvester)



The same approach can be applied to many other industrial applications (e.g. automatic machineries)

Case Study 1
Safety on Off-Highway Vehicles

Developed End Device



- **Commercial**
  Piezoelectric Transducers (EH)
  ULP µC, ULP 3-axial Accelerometer, ULP Temperature Sensor
- **Customized**
  Low Power front-end electronics with smart power management
- **HW-SW Co-Design**
- V_{DD}: 2.0V÷3.3V
- $P_{STAND\text{-}BY}$: <5µW
- P_{active_AVG} µC running: <10µW
- P_{active_AVG} µC running & RF TX: 27µW
- TX @ 2.4 GHz (802.15.4 standard)

Case Study 2
Relative Positioning of Articulated Systems

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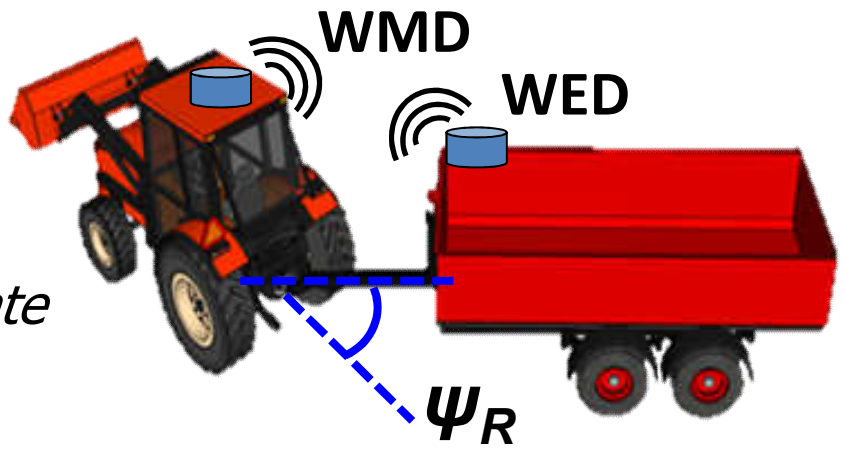
- ***Detection of Dangerous Working Conditions of the WHOLE MACHINERY***
- *Pitch, Roll, Yaw angle of both tractor and trailer needed to estimate the* ***Relative Yaw Angle*** ψ_R



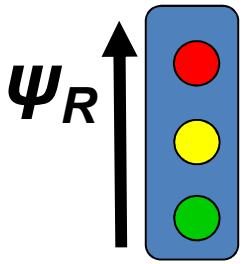
	WMD	WED
Power Supply	Tractor Battery	VIBester with Back-up Battery
Connectivity	Wireless 802.15.4 with WED CAN bus towards the main tractor ECU	Wireless 802.15.4
Sensors	3D MEMS Accelerometer with integrated 3D Magnetometer	3D MEMS Accelerometer with integrated 3D Magnetometer
Main Features	Complex Mathematical Computation of Yaw Angles -> Risk Level Detection	Smart Task Manager Algorithm (ULP Consumption)

Vibrations identify the working state

- If Higher than a defined threshold => ***Trailer ON Duty*** (Active State)
- If Lower than a defined threshold => ***Trailer OFF Duty*** (Parking State)

Pitch & Roll angles of the Trailer/Implement **used to identify its Risk Level Condition (RLC)**

- PWR consumption depends on Sampling Data Rate, µC Clock Frequency, Power Supply, …, which in turn depend on estimated instantaneous RLC



Different planes, tilted
Same plane, tilted
Same plane, not tilted

Different Warning Thresholds for Safe Working Conditions of the WHOLE MACHINERY

Case Study 3
Active Safety System for Telehandlers

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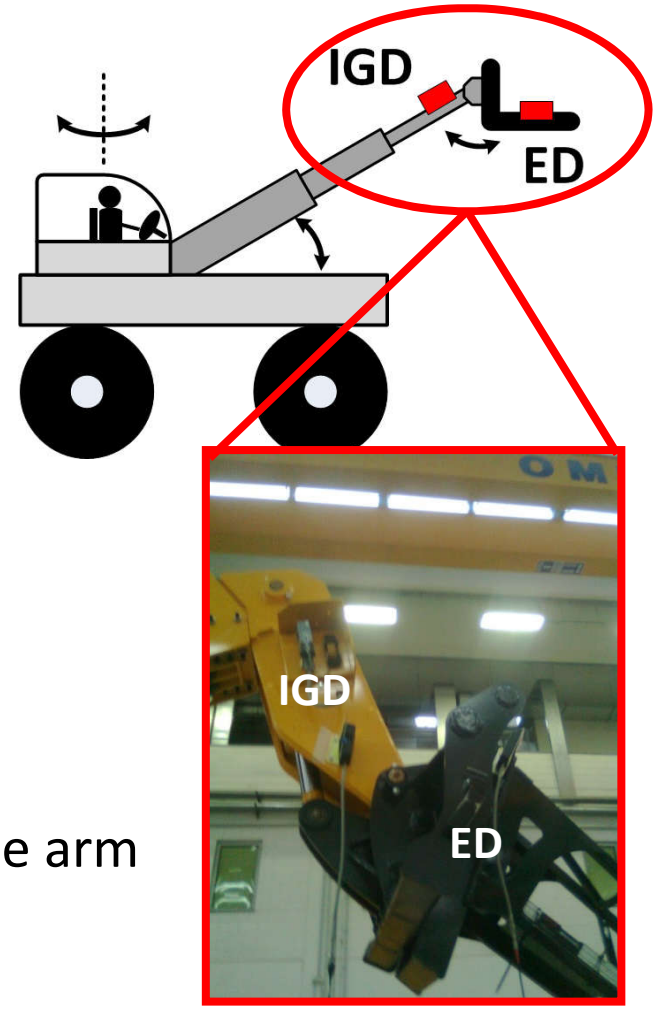
The **Automatic Identification of connected implement** (with main parameters) enables:

- Optimal load charts for every implement in use and for every working condition (***Productivity Improvement***)
- Real-time update of the input parameters of the vehicle control stability algorithms ***(Active Safety Enhancement)***



System comprised of

- ***Illuminator/Gateway Device (IGD)*** on the arm
- ***End Device (ED)*** on the implement

Case Study 3
Active Safety System for Telehandlers

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RF Power Delivery System

Main characteristics

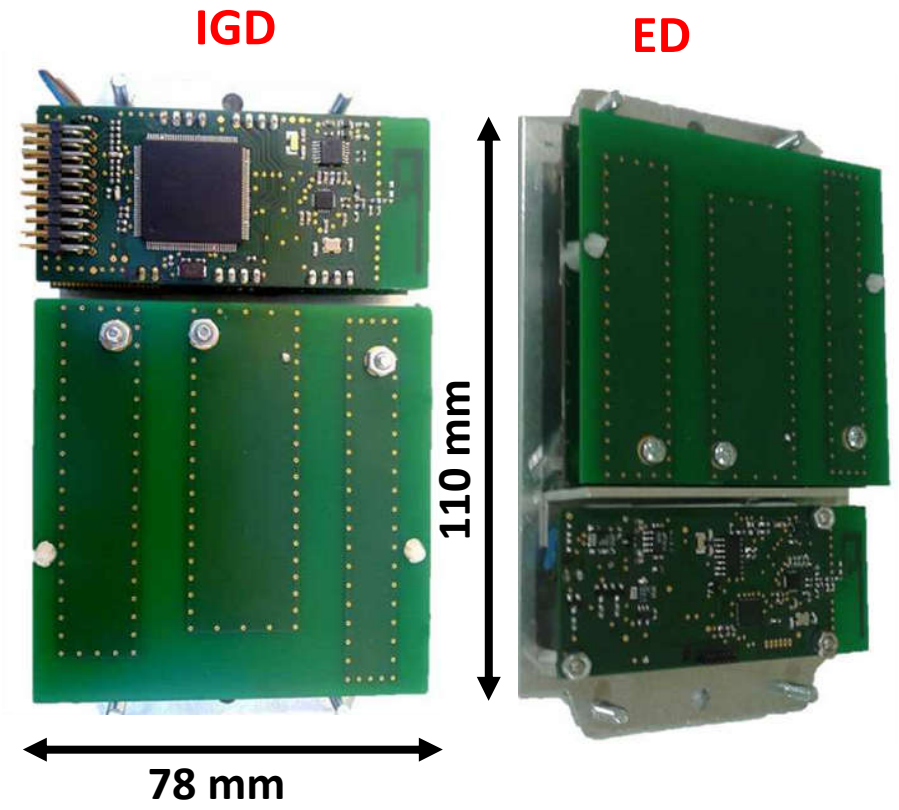
- **IGD** -> RF PWR generation in ISM band
- **ED** -> RF PWR harvesting
- Customized Dual Band Antenna for PWR-Delivery compliant with EU and US regulations

IGD

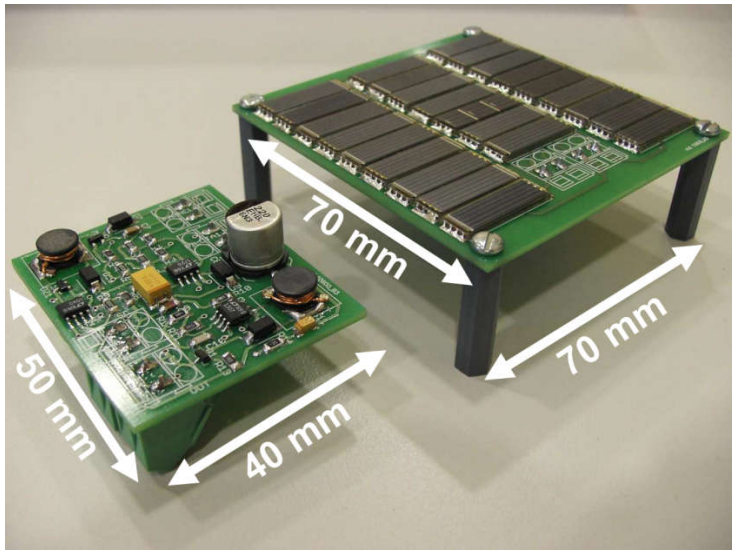
- Architecture with 2-core lock-step µC
- CAN communication with other ECUs
- 2.4 GHz IEEE 802.15.4 data transfer

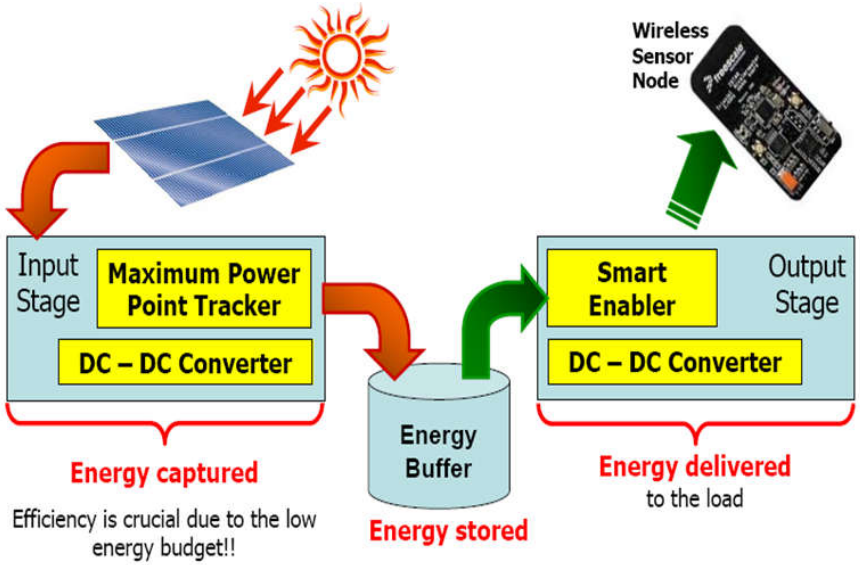
ED

- Working conditions datalogging
- Smart Power Manager



Case Study 4
Autonomous WSN powered by a Solar EH

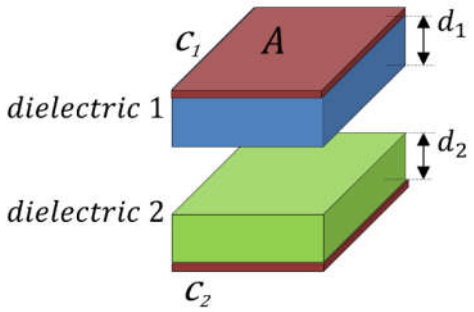


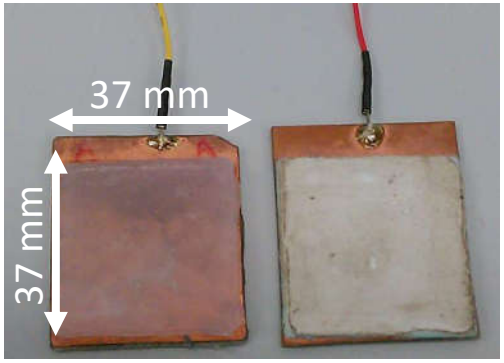


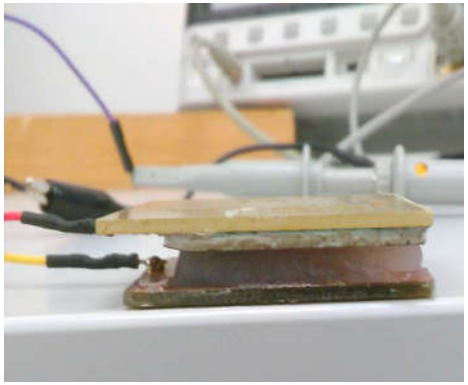
- **Customized solar panel**
- **Customized Input Stage with MPPT**
- **Commercial Output Stage**
- Power delivered to the load: Up to 130mW
- Energy Storage: Super Capacitor
- Input Stage Conversion Efficiency: Up to 92%

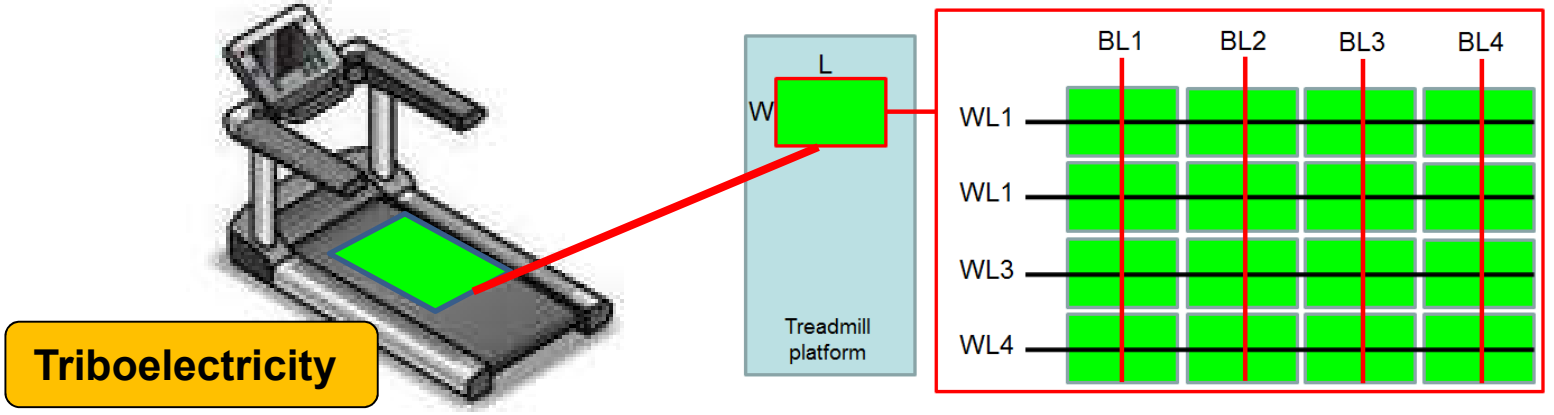
Case Study 5
Low Cost Gait Monitoring System

Target: provide the same information of high cost pressure platforms or instrumented treadmills at very low cost









Contacts

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