EnerHarv 2024

PSMA International Workshop | 26-28 June, 2024 | Perugia, Italy

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EnerHarv 2024 Workshop:

Enabling the Future of Massive IoT: Overcoming Integration Challenges for Maintenance-Free Wireless Sensor Nodes

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Friday, June 28, 2024

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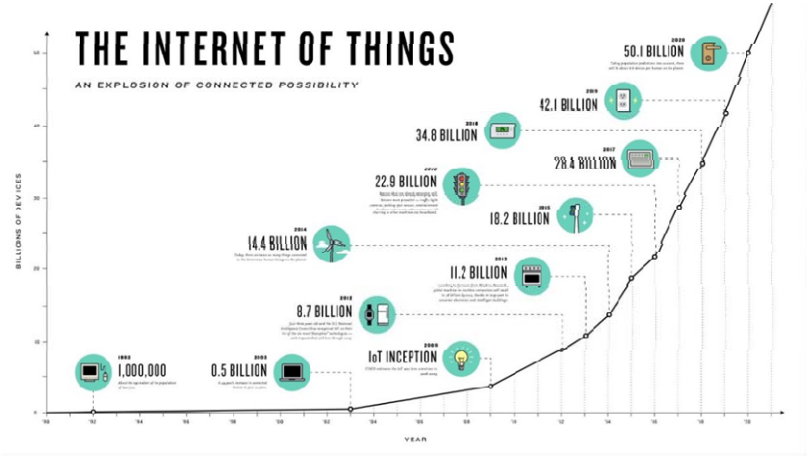
OVERVIEW

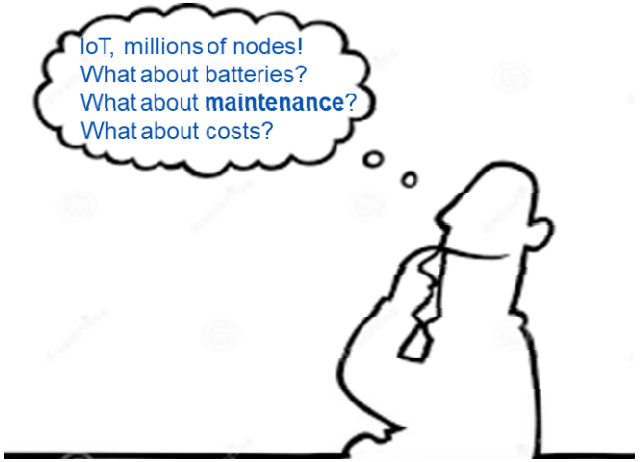
- **System Integration Challenges**
- **Cost Considerations for Massive Deployment**
- **Maintenance-Free as a Catalyst for IoT Growth**
- **Practical Use Cases**

Massive IoT: challenges and opportunities



"For every trillion nodes installed, 274 million batteries would need to be replaced every day, even in the best-case where batteries reach their 10-year life expectancy."

'The global smart sensor market size is expected to grow from USD 36.6 billion in 2020 to USD 87.6 billion by 2025, at a CAGR of 19.0%'



The main problem with traditional electronics: sustainability x3 | social, ecological, economic

The IoT and sensors business generate a huge amount of electronic waste.

More than 30 billlions of primary batteries are thrown away every year as a result.

And this number is going to increase.

At the expected growth rate of electronics, **there will be raw materials shortage by 2030** .

This will result in a **significant production cost increase for traditional electronics**.

This is why the time is now for moving forward and overcoming the current electronics sustainability issues and dependencies.

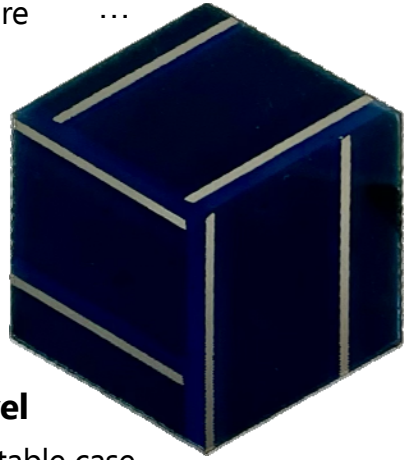
System Integration Challenges

1. Sensors

.Ammonia NH_3
.Air/soil temperature
.Air/soil Humidity
.Air pressure
.CO_2
.Soil pH
…

2. Energy harvesting

.Solar cells
.Microbial Fuel Cells
.Vibrations
.Temperature differential
…



3. Data processing

.with embedded AI
.cloud
.no data processing

4. Data transmission

.BLE
.LoRa
.LEO satellites

5. Data storage and distribution

6. Sustainability level

.Recyclable or compostable case
.2° life electronics
.Printed circuits
.battery-less
…

System Integration Challenges

Problem

Huge Number of Wireless Sensor Nodes

Solution

Co-Design

Requirements

- Maintenance-free
- Wire mitigation
- Low-cost
- Compact form factor
- End of life / Recyclability
- Easy to Use

Key features

- Energy autonomous
- Wireless communication
- Design Optimization / Co-Design
- Energy Efficiency
- Sustainable Materials
- Set-and-forget device

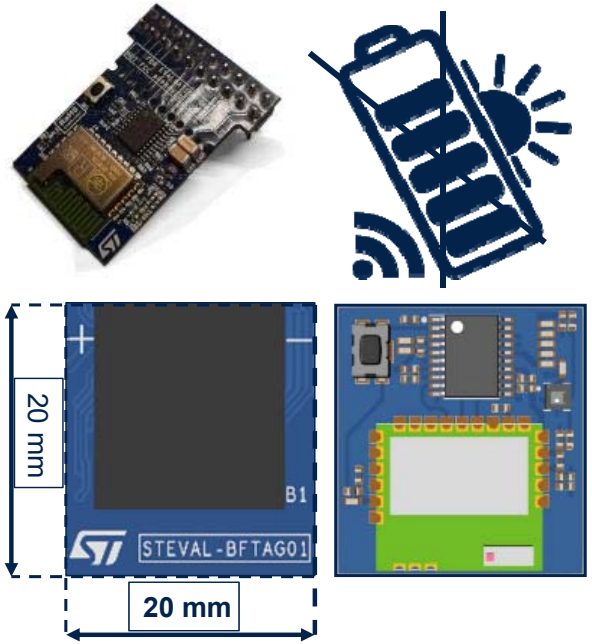
Maintenance-Free Wireless Sensor Platform

Highlights
- Energy-autonomous device
- Sensor-free light monitor
- Relative humidity and temperature monitor

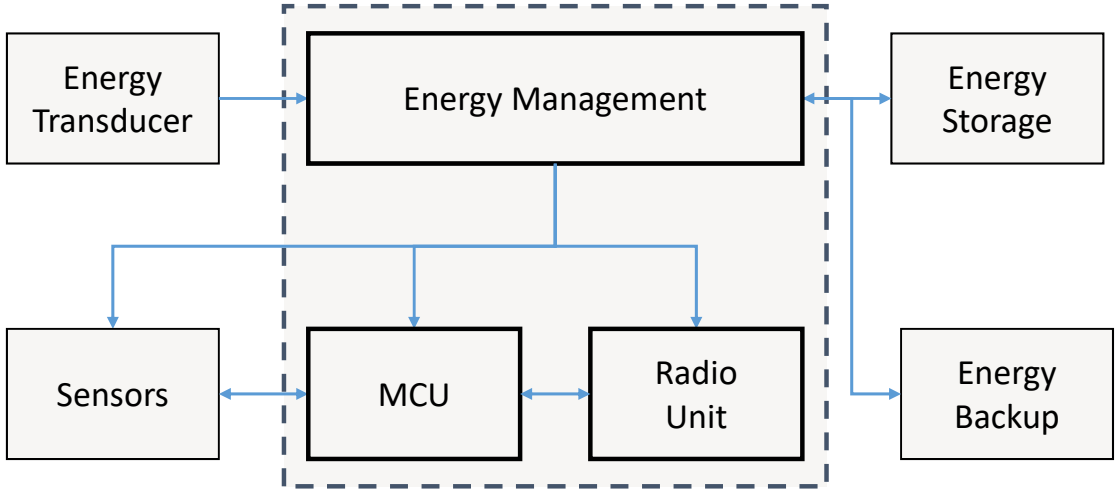
Features
- Small form factor
- Bluetooth Low Energy (BLE) connectivity
- Low-cost solution
- Digital read out

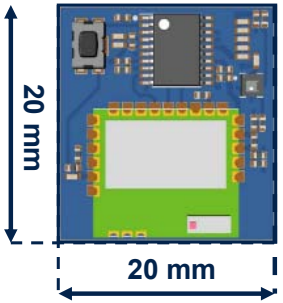
Applications
- Ambient light monitoring
- Predictive maintenance
- Asset tracking

How it works:
- It sends several beacons proportioned to the intensity of ambient light
- Self-powered by energy harvesting, e.g. a small solar panel



Maintenance-Free Wireless Sensor Node





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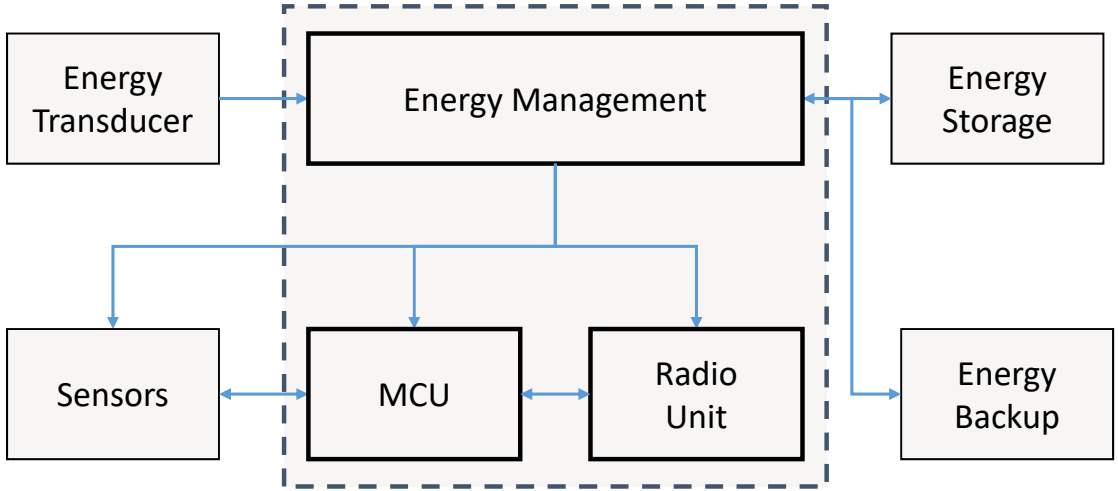
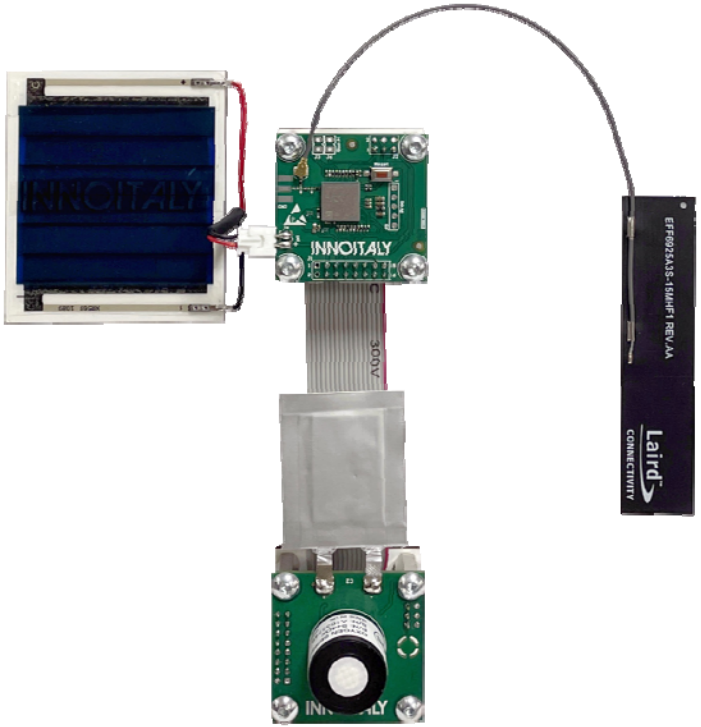
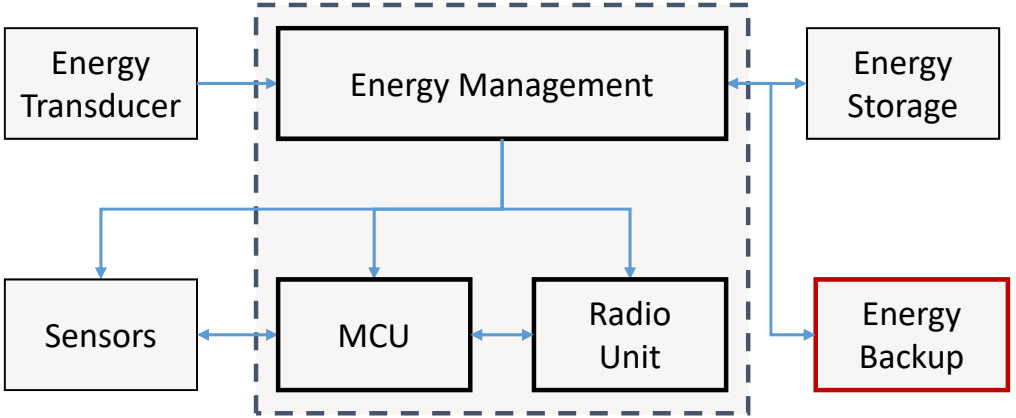
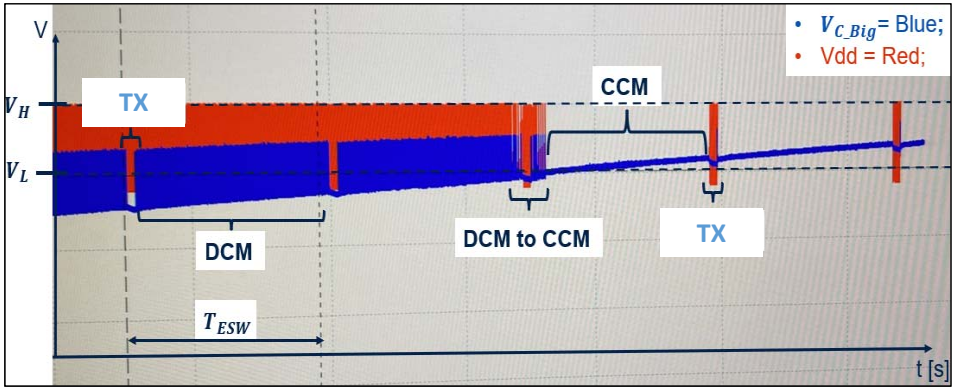




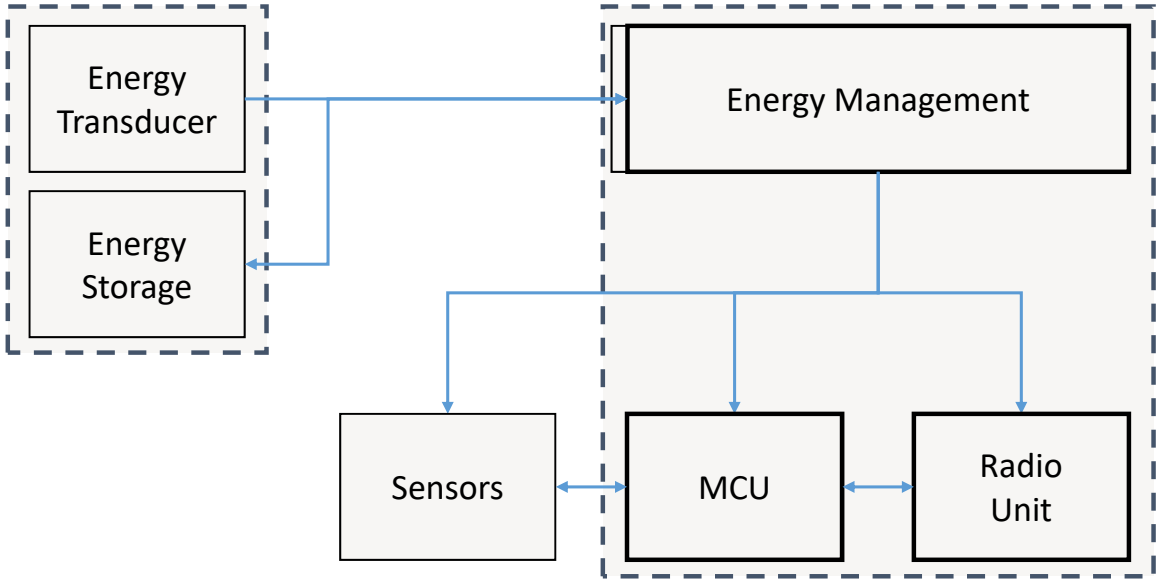
Maintenance-free Wireless Sensor Node



- STM32W* consumes **25 mJ / hour in sleep mode**
- 1F capacitor keeps STM32W* in sleep mode for **4 days**

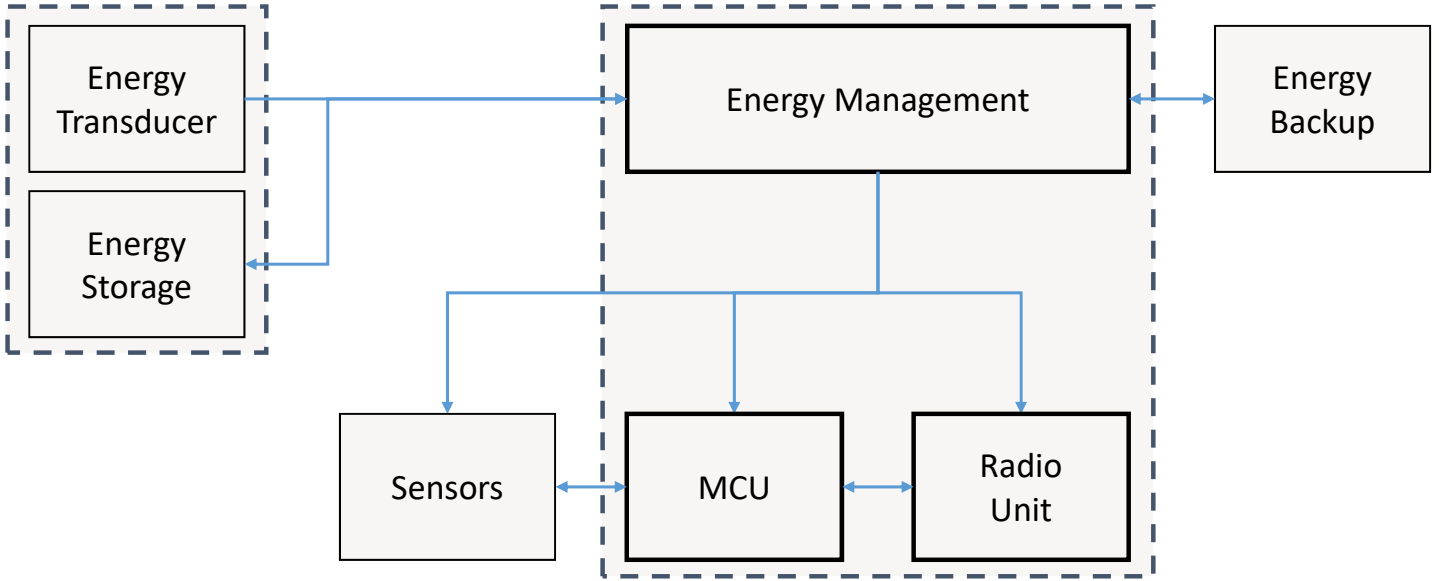


Cost effective solutions … What if ?



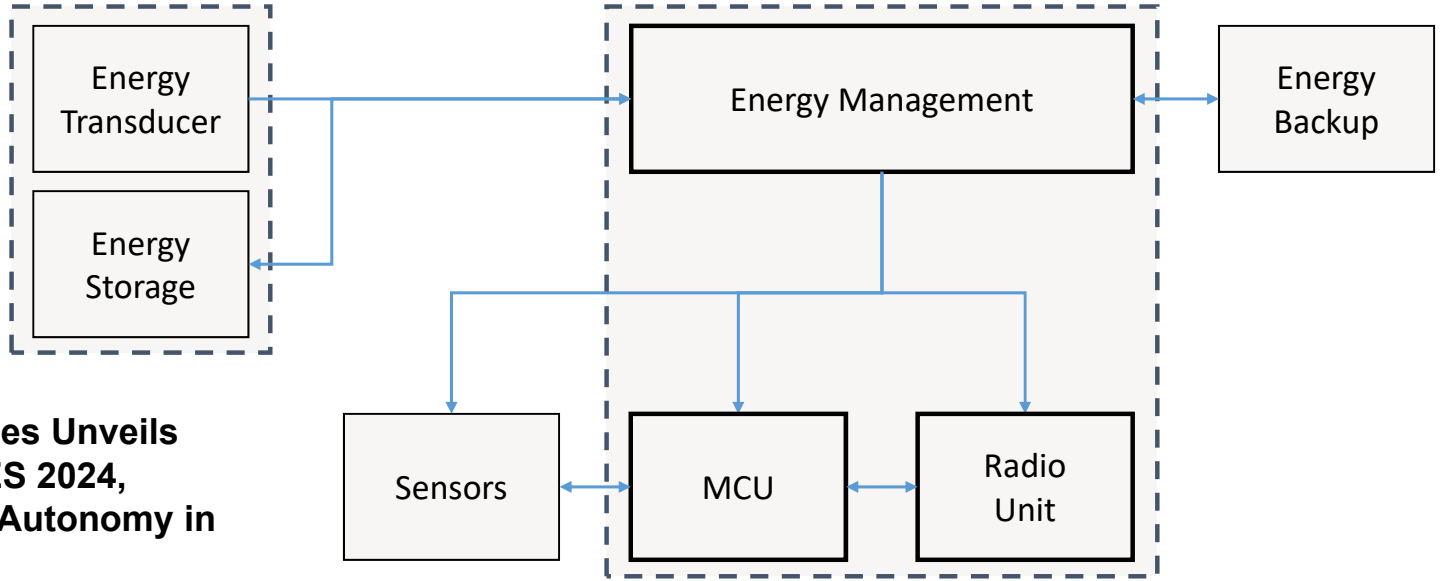
Cost effective solutions … What if ?

DRACULA TECHNOLOGIES

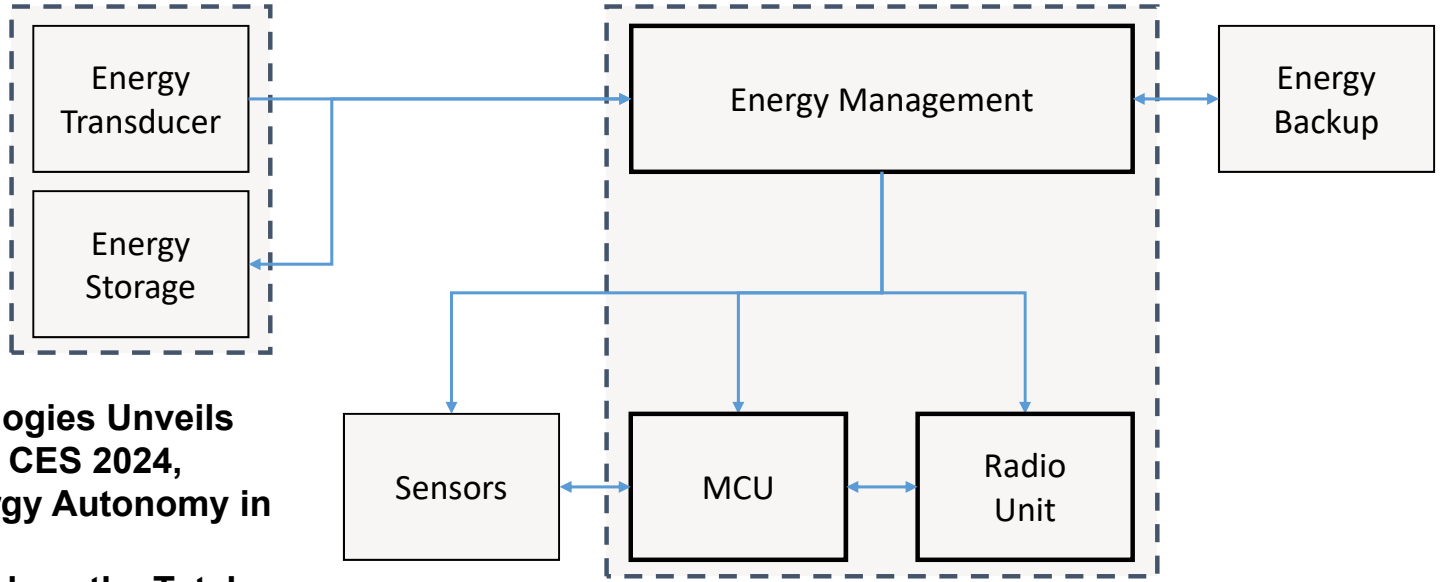


Cost effective solutions … What if ?

Dracula Technologies Unveils LAYER®Vault at CES 2024, Redefining Energy Autonomy in IoT Electronics

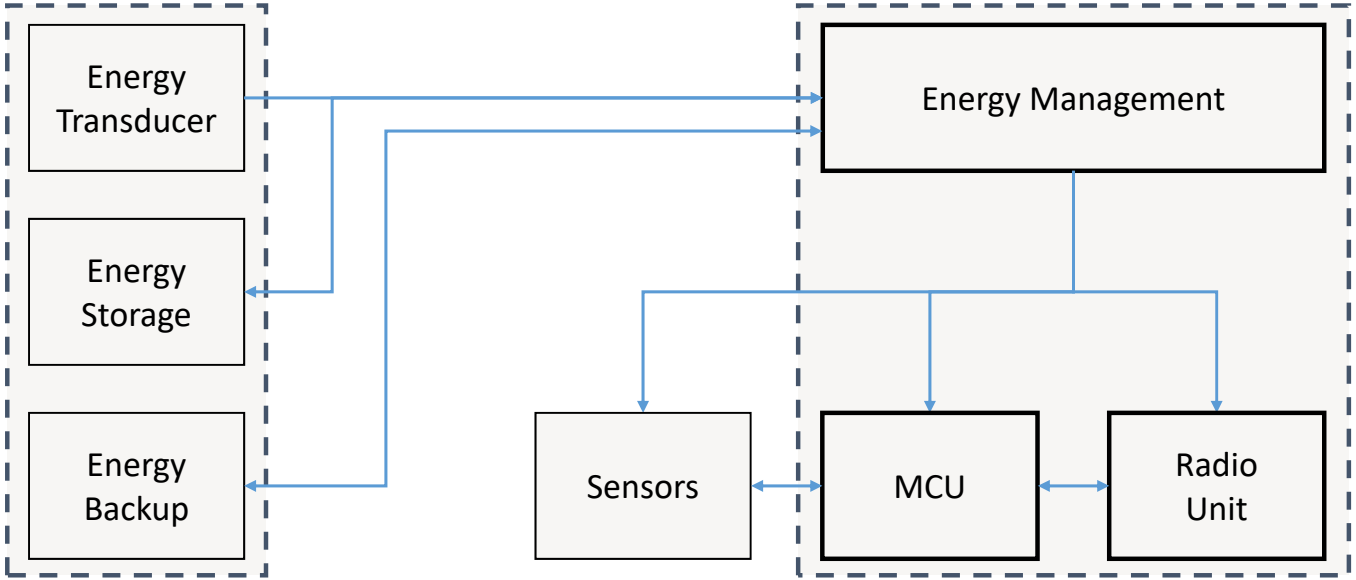


Cost effective solutions … What if ?

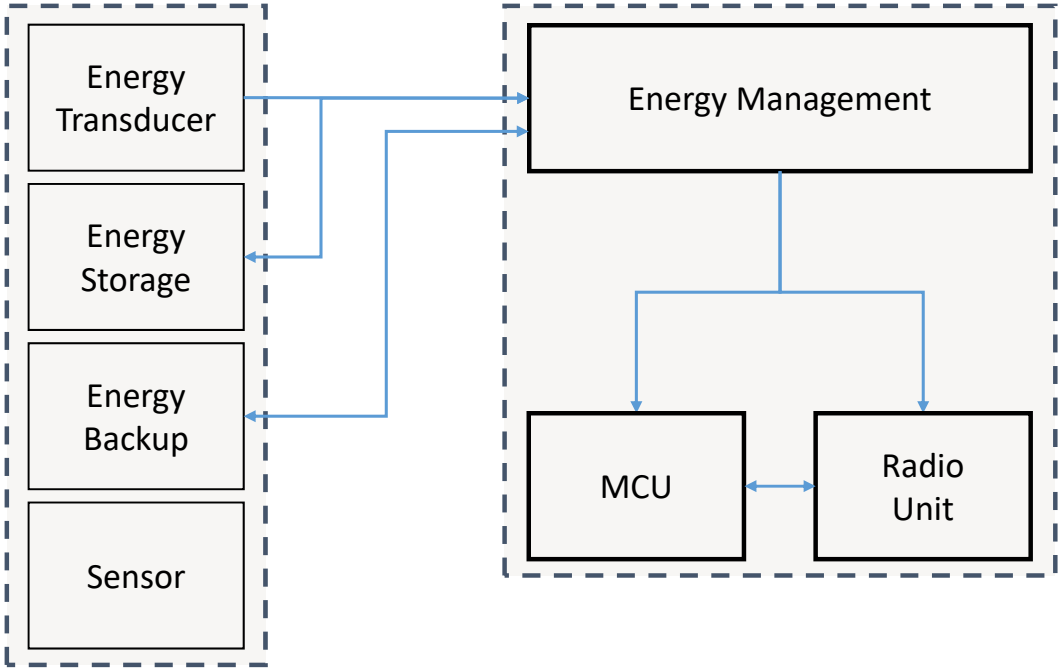


- **Dracula Technologies Unveils LAYER®Vault at CES 2024, Redefining Energy Autonomy in IoT Electronics**
- **Significantly Reduce the Total Cost of Ownership of your IoT Solution with LAYER®.**

Cost effective solutions … What if ?



Cost effective solutions … What if ?



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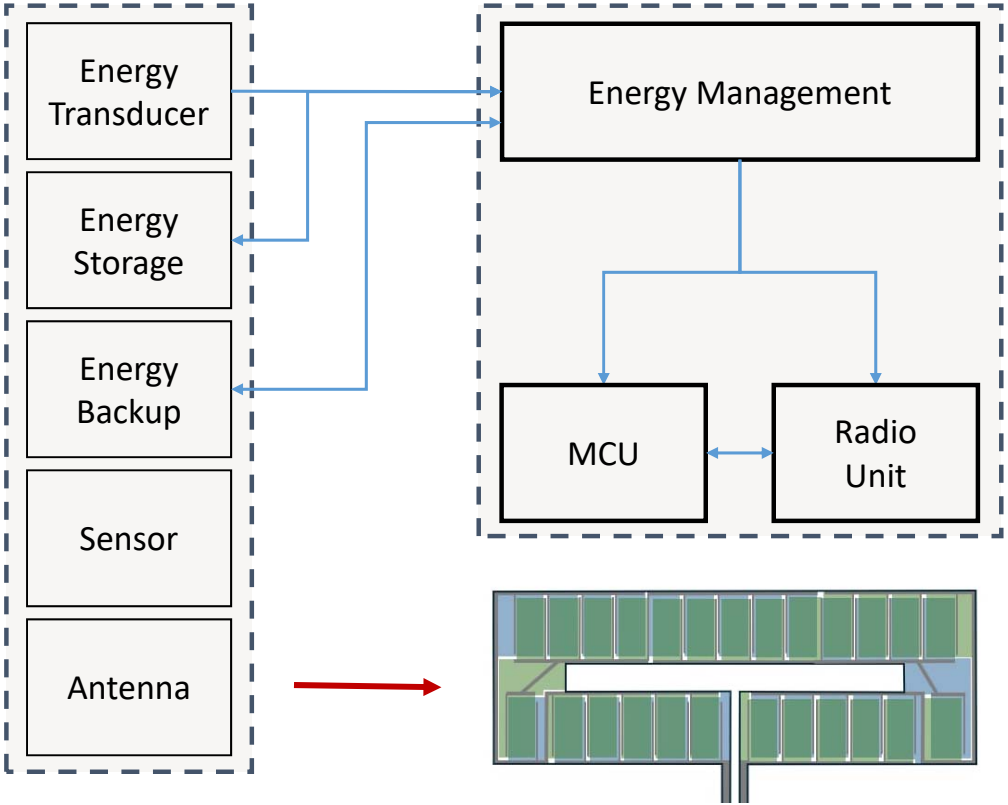

Energy-independent sensor platform

Sector	• Home automation • Outdoor automation • Home gardening
Main features	• 360° solar cell dome • Battery-Free • BLE | LoRa data transmission
Collected data	• Air humidity • Temperature • Light Intensity
Added value	• Maintenance-free • Ideal for expansive WSN Deployments

Solution for Preserving Precious Artworks

Sector	• Home automation • Indoor automation • Museum automation
Main features	• 360° solar cell dome • Battery-Free • BLE & LoRa data transmission
Collected data	• Air humidity • Temperature • Light Intensity • Inclination • Presence
Added value	• Maintenance-free • Ideal for expansive WSN deployments

Energy-independent sensors with Microbial Fuel Cell

Sector	• Agritech • Farm • Home gardening
Main features	• Energy-Autonomous • Battery-Free (Co-Harvesting Solar Cell + PMFC) • BLE & LoRa
Collected data	• Air humidity • Temperature • Soil humidity | temperature | pH • Light Intensity
Added value	• Maintenance-free • Ideal for expansive WSN deployments

Conclusions

- **Energy Harvesting enables Massive IoT**
- **Massive IoT applications are cost sensitive**
- **System Integration needs off-the-shelf devices**
- **Co-design can help reducing integration costs**
- **Needed more variety in off-the-shelf transducers**
- **Yet not a lot available on the market beyond photovoltaic**

Q & A

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Thanks very much for your time and attention!

Questions/comments???

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References

- https://www.innoitaly.com/
- https://www.st.com/resource/en/flyer/flstm32wl.pdf
- https://dracula-technologies.com/layer-vault/
- La Rosa, Roberto, et al. "An Energy-Autonomous and Maintenance-Free Wireless Sensor Platform with LoRa Connectivity." *2023 12th International Conference on Renewable Energy Research and Applications (ICRERA)*. IEEE, 2023.
- La Rosa, Roberto, et al. "An energy autonomous and battery-free measurement system for ambient light power with time domain readout." *Measurement* 186 (2021): 110158.
- La Rosa, Roberto, et al. "A Self-powered Ambient Light Power Measurement Platform with Time-domain Readout." *2021 IEEE International Instrumentation and Measurement Technology Conference (I2MTC)*. IEEE, 2021.
- La Rosa, Roberto, et al. "Strategies and techniques for powering wireless sensor nodes through energy harvesting and wireless power transfer." *Sensors* 19.12 (2019): 2660.