Resilient Large-Scale Systems:
Building the Intelligent Environment

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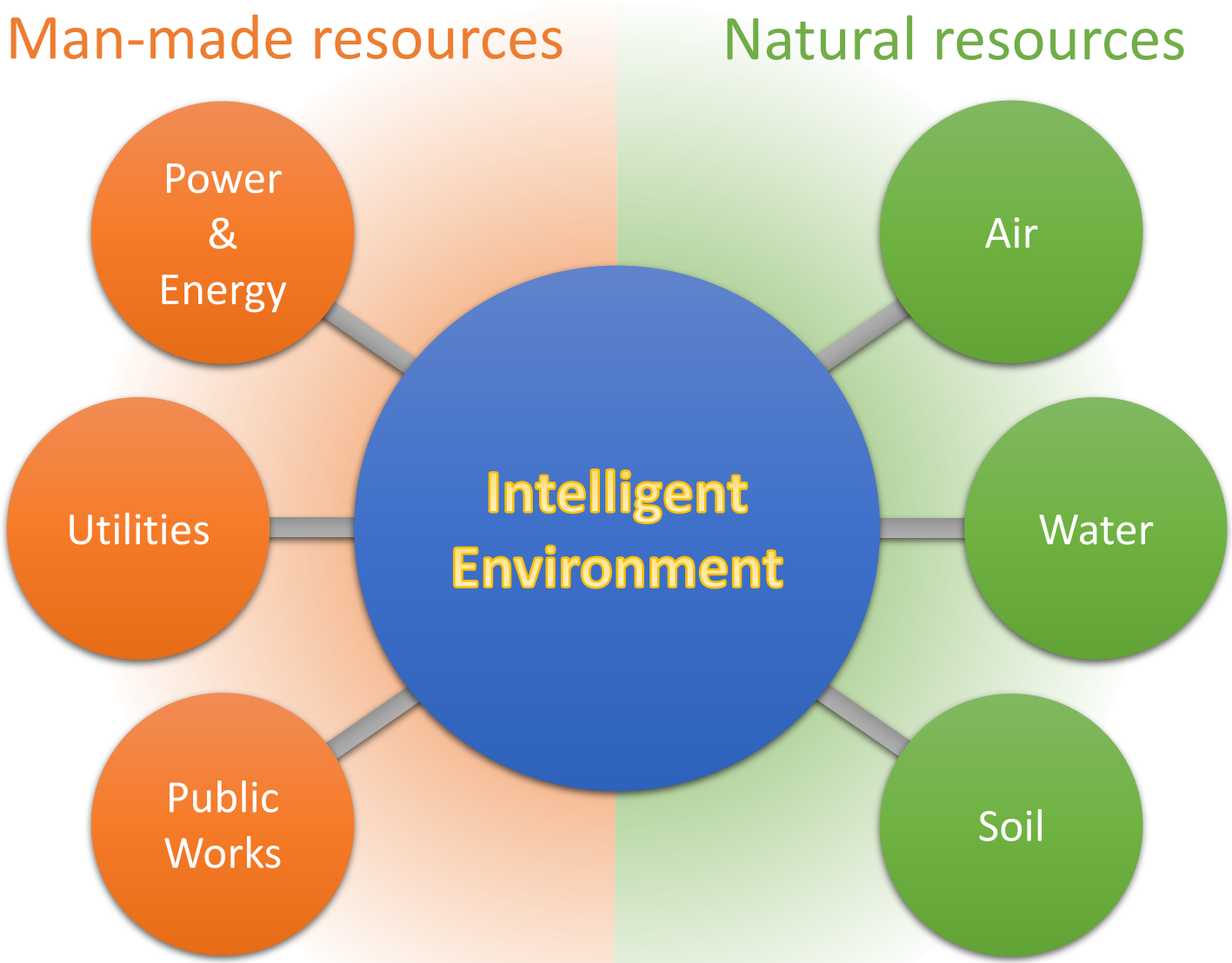
May 9, 2018

Food
Health
Quality of Life
Economy



Fine-grained Data-driven:

Resource management

Planning

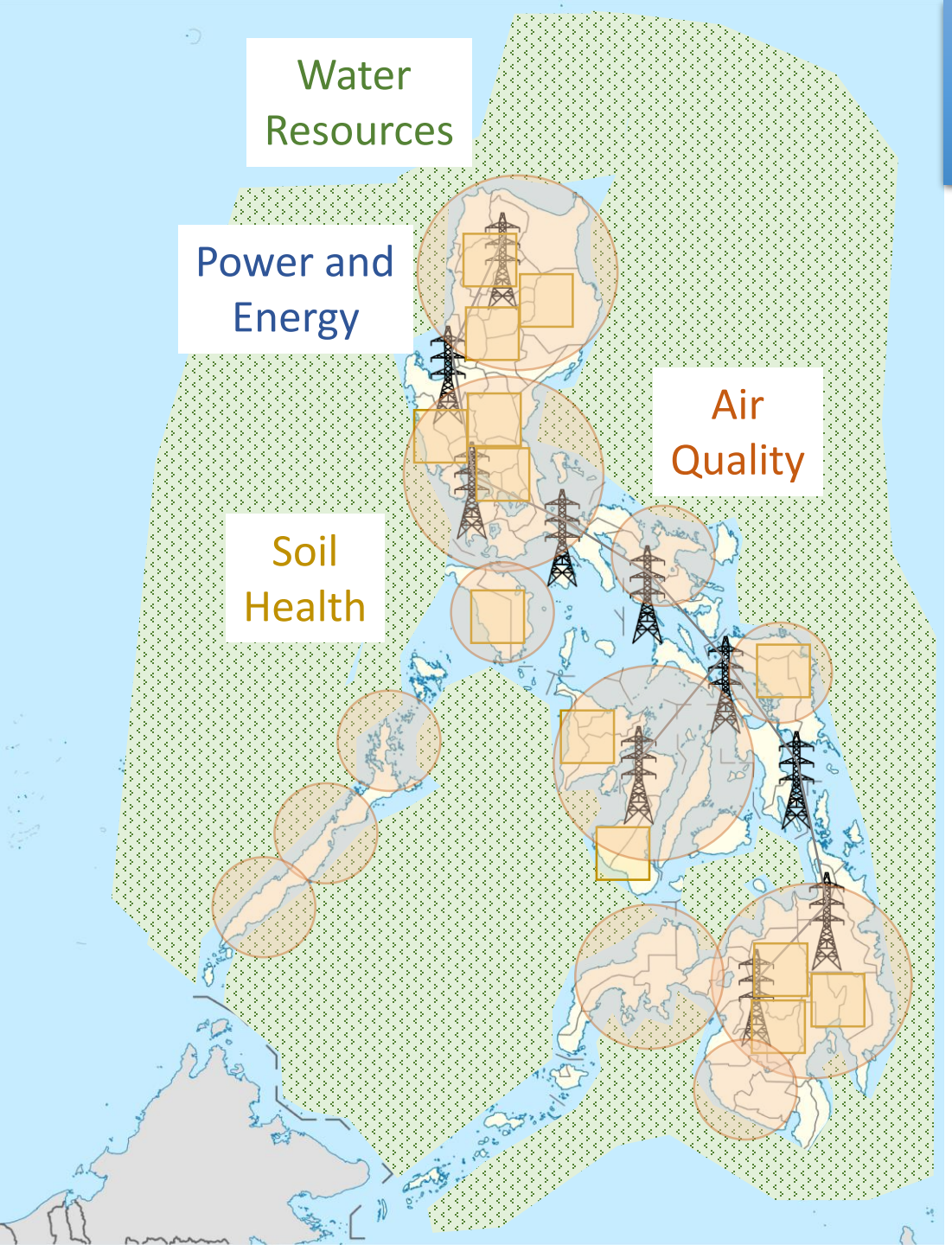
Policy making

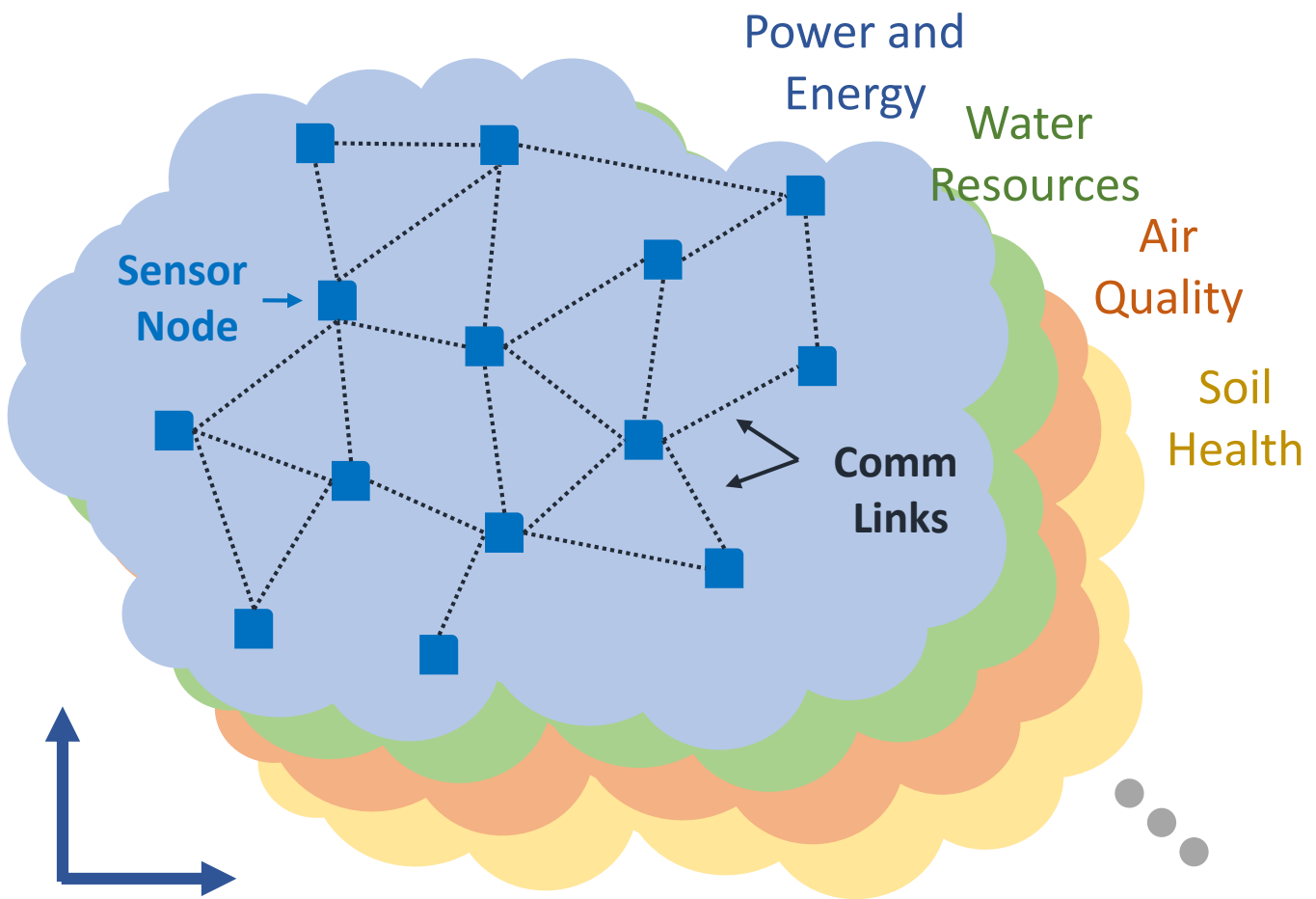
Enforcement

Risk and disaster management

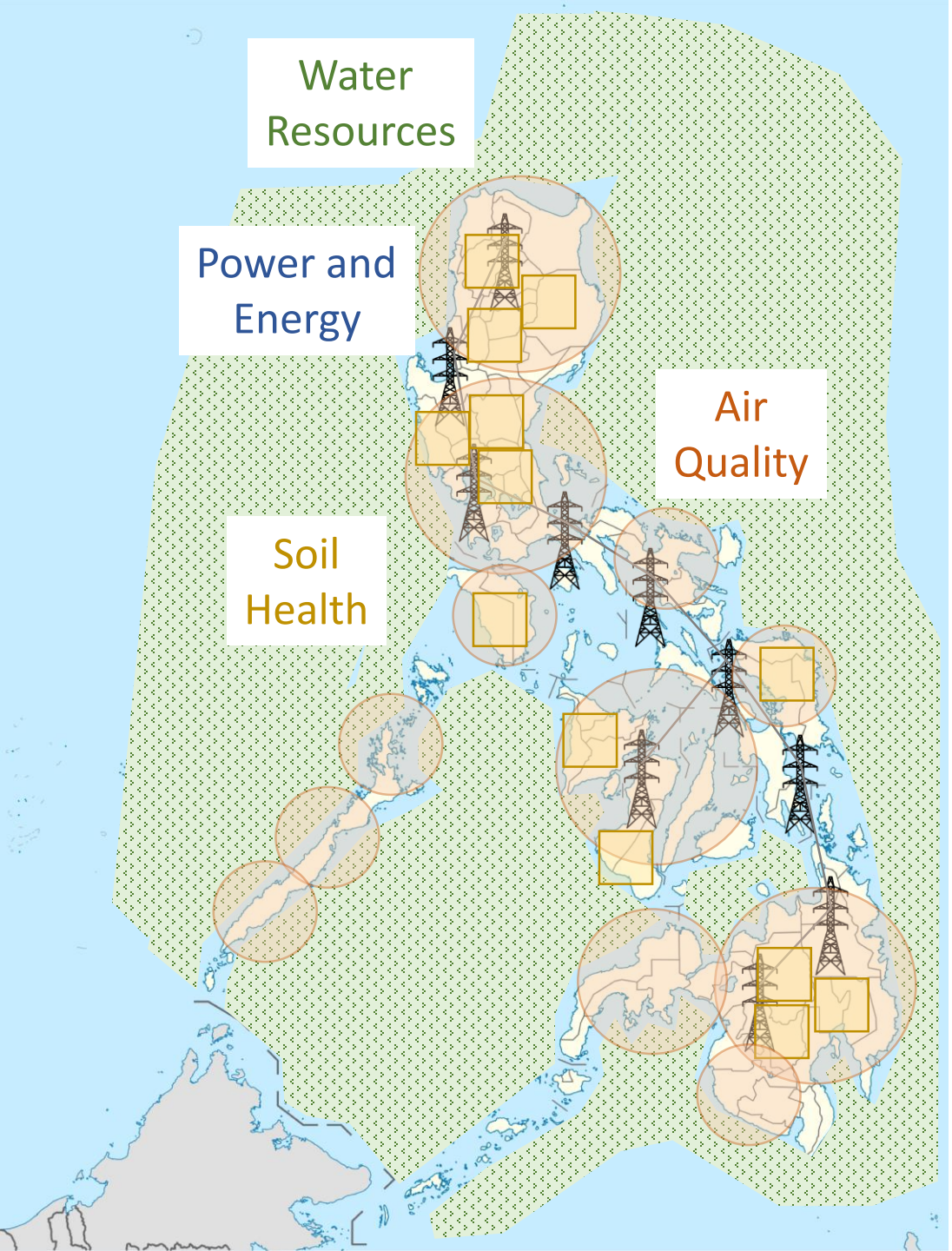
KEY: Understanding the **interactions** between resources!

Large-Scale Systems:
Building The Trillion-Node Network





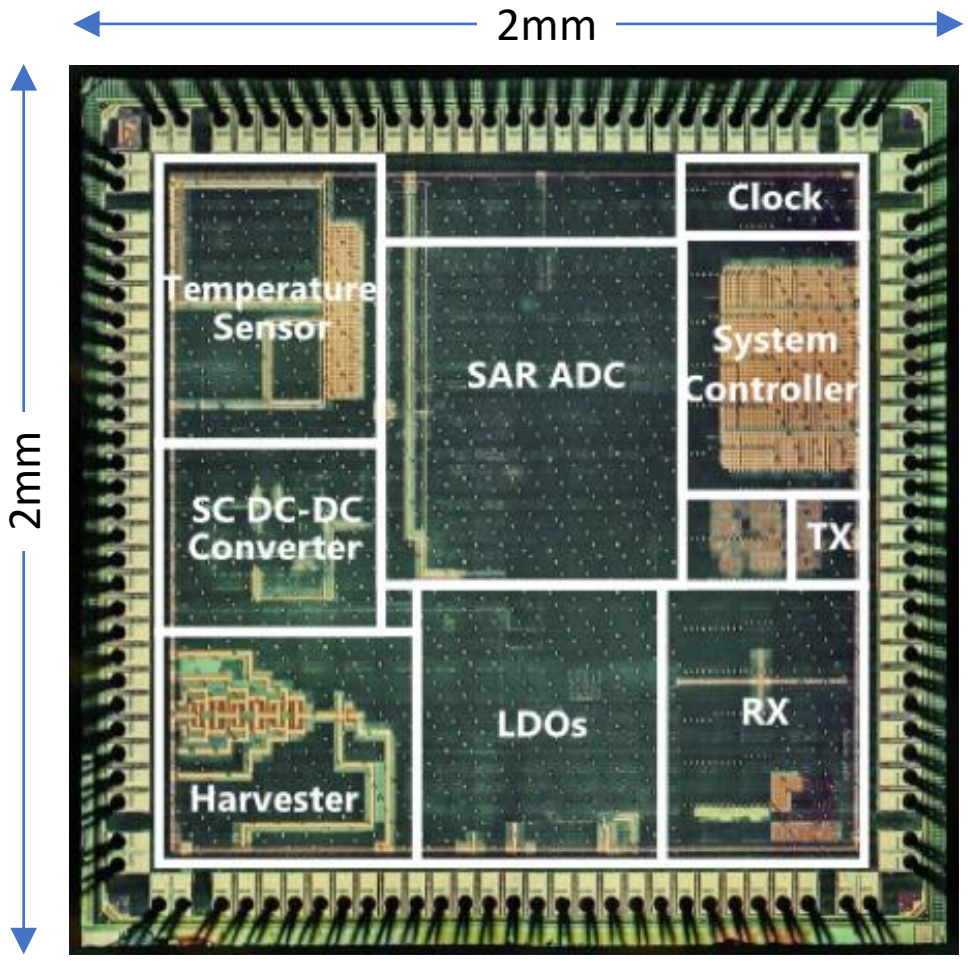
Increasing Node Count and Coverage Area



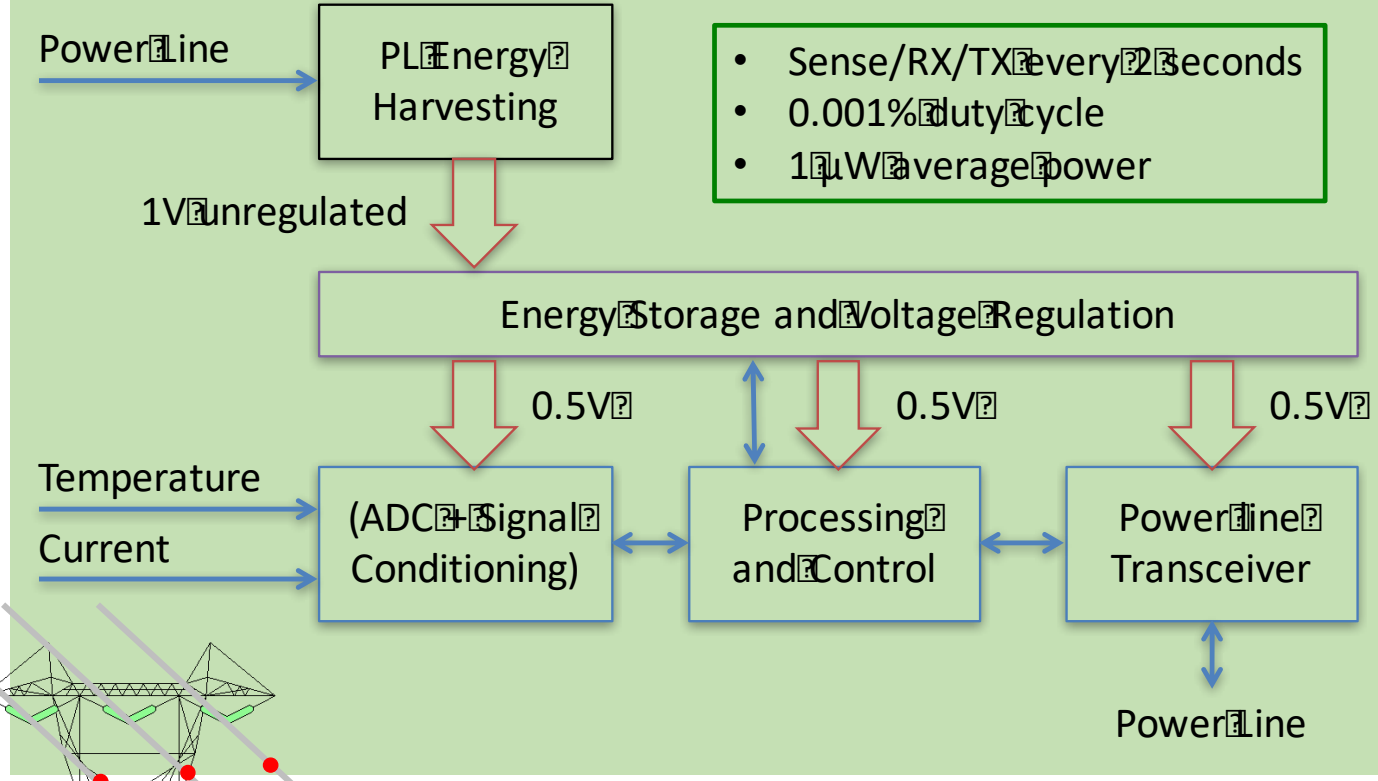
1. Zero-Maintenance
2. Scalable
3. Resilient

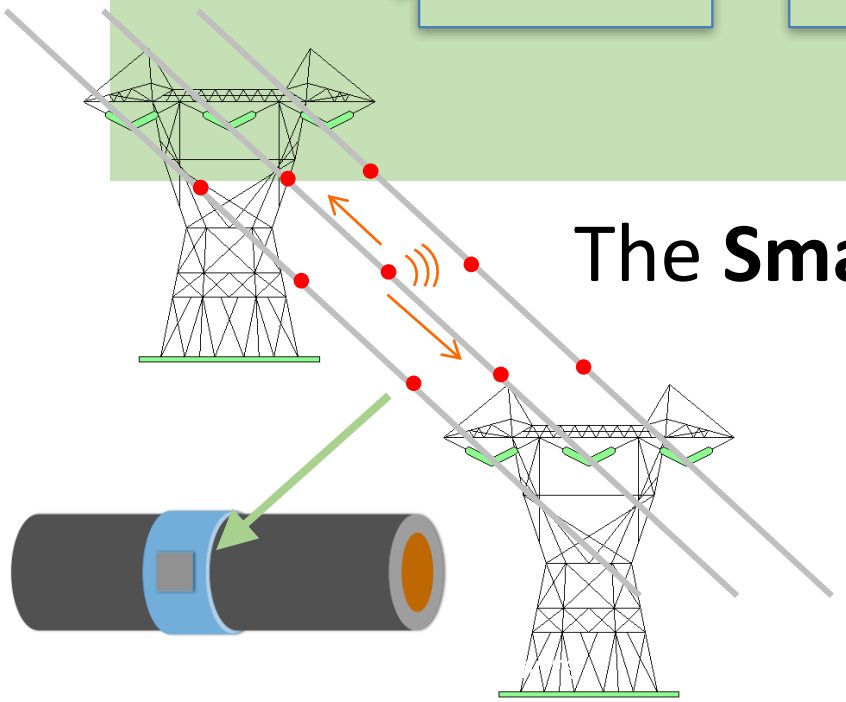
Zero Maintenance = Energy Independence

Energy Harvesting



65nm CMOS Integrated Sensor Node

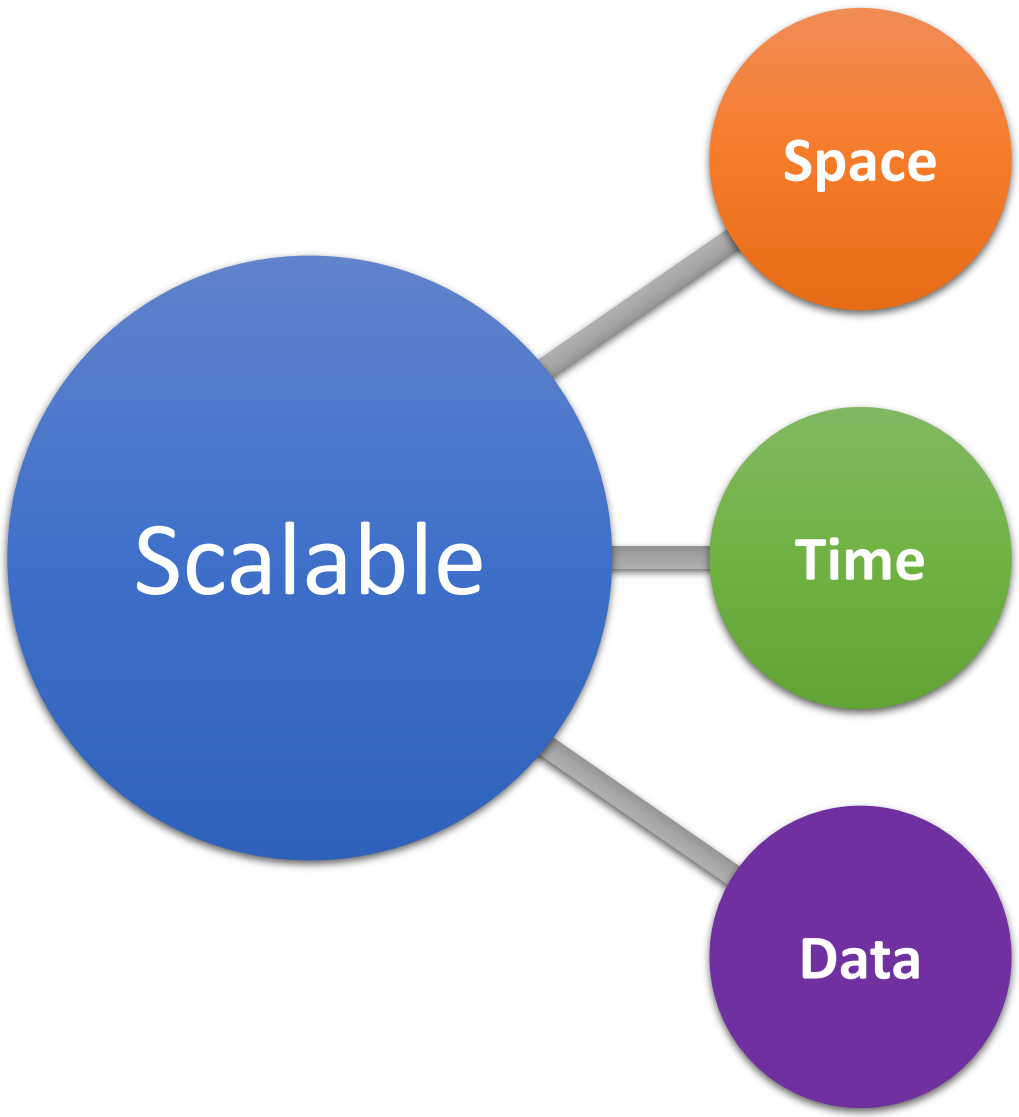


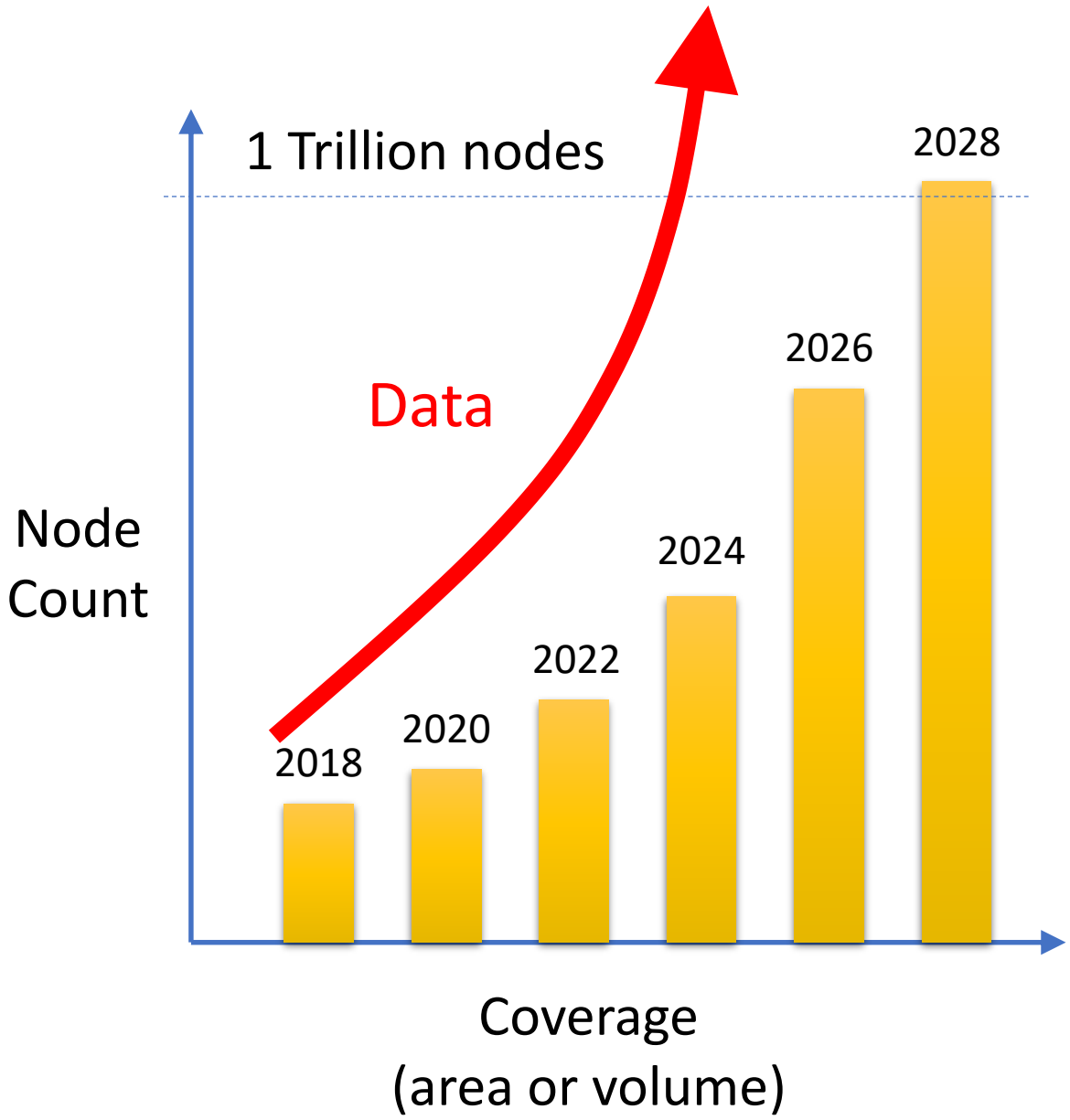


The **SmartWire** Project

PCIEERD Funded

A. Chua, R. Maestro, J. Jardin, K. Monisit, R. Nuestro, K. Fabay, B. Pelayo, W. Lofamia, J. Ortiz, J. Madamba, L. Alarcon, **"SmartWire: A 0.5V 44uW 0°C to 100°C power-line energy harvesting sensor node"**, *2017 IEEE Custom Integrated Circuits Conference (CICC)*, Austin, TX, 2017


Scalable
Space
Time
Data


1 Trillion nodes
2028
2026
Data
2024
Node
Count
2022
2020
2018
Coverage
(area or volume)

The GDP: A Framework for **Scalable Innovation**

Applications

Energy + air quality application

Water + air quality application

Energy application

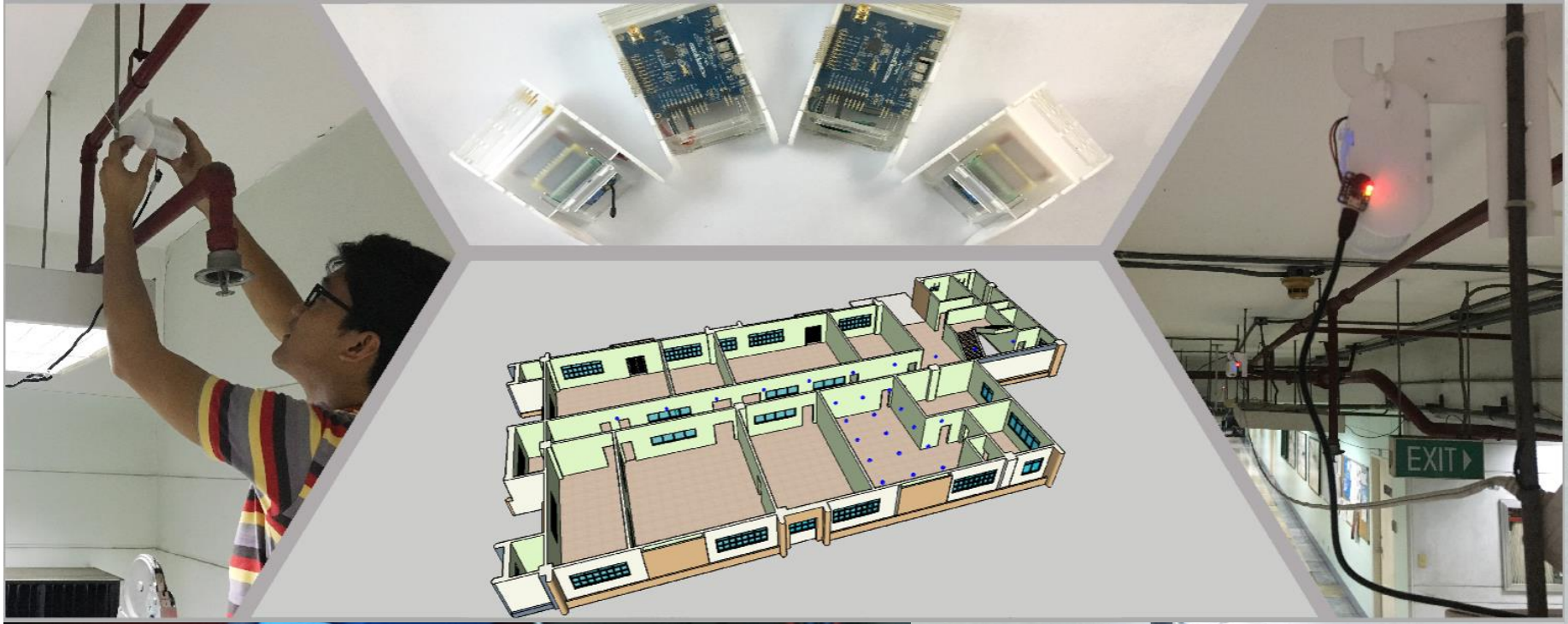
Air quality application

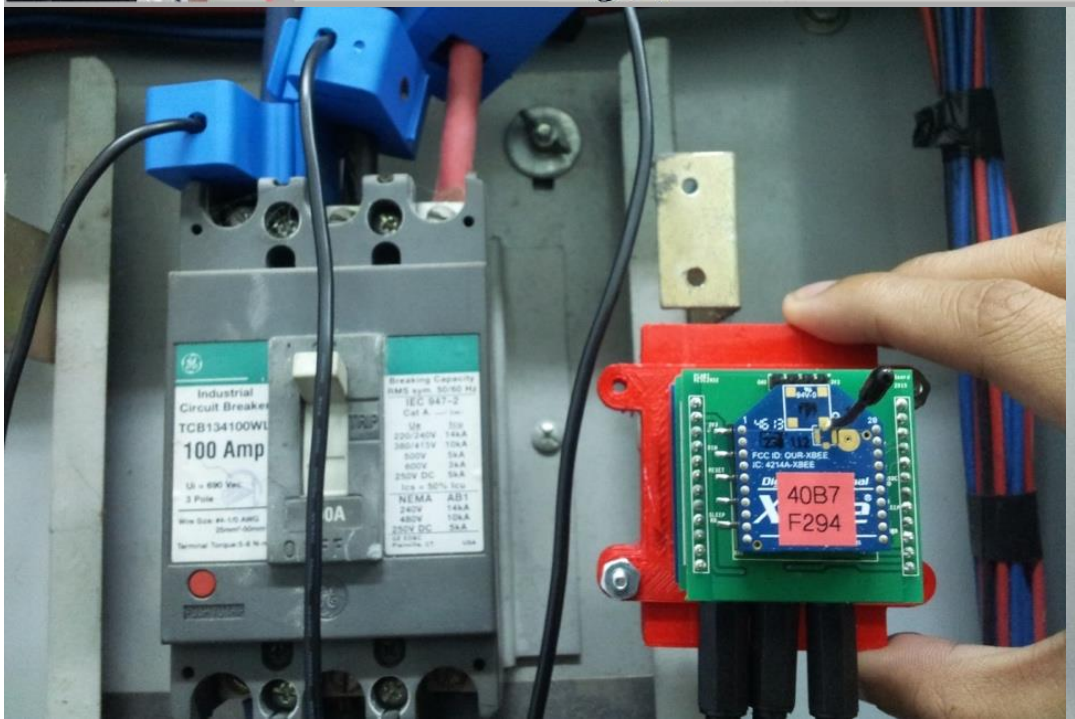
Water quality application

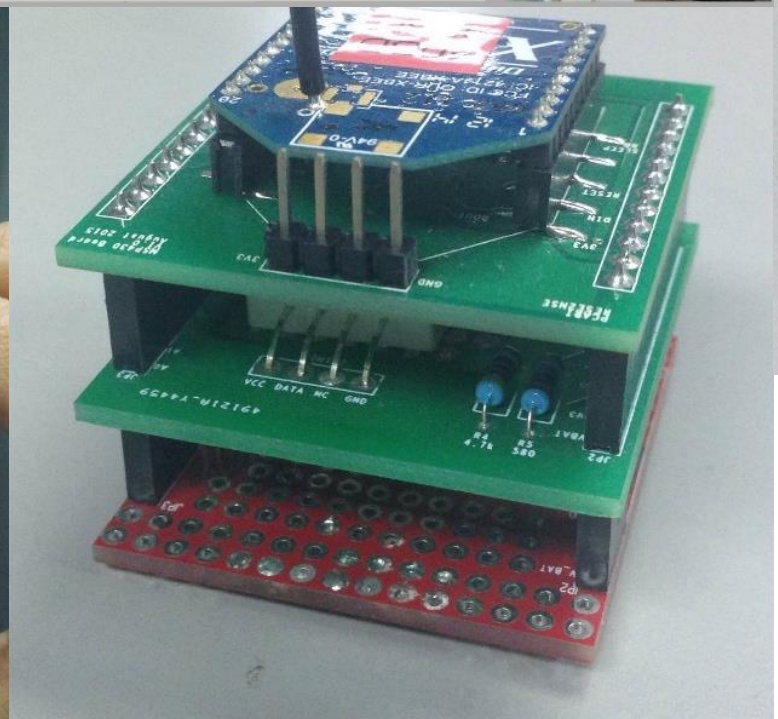
RESE2NSE Global Data Plane

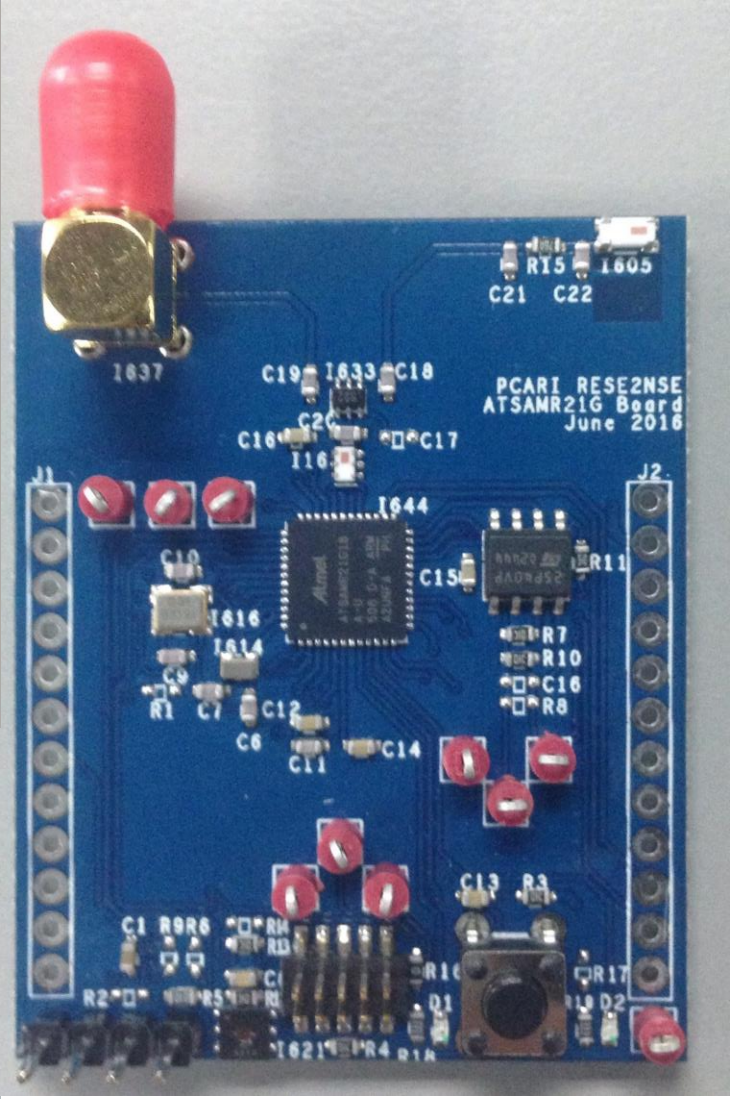
UP Diliman

UC Berkeley





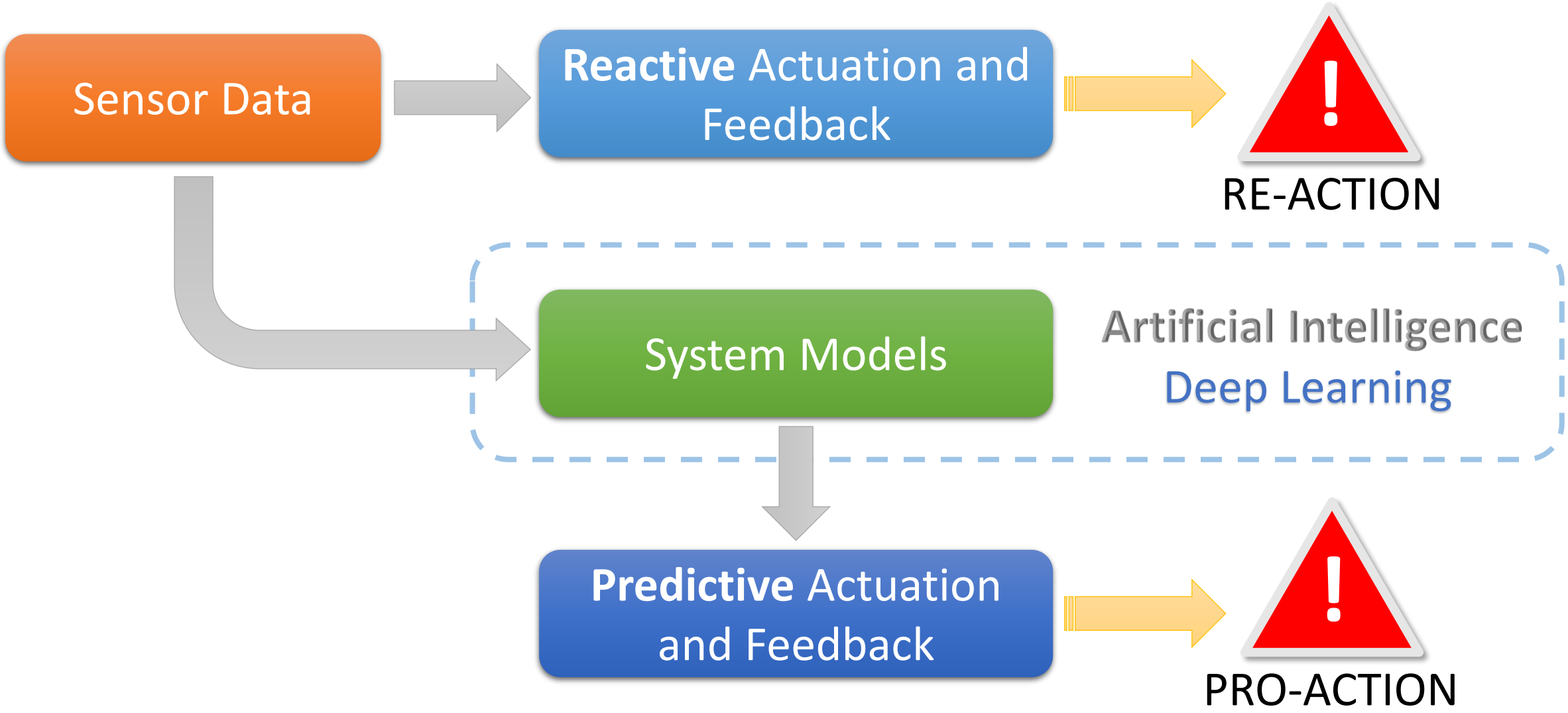




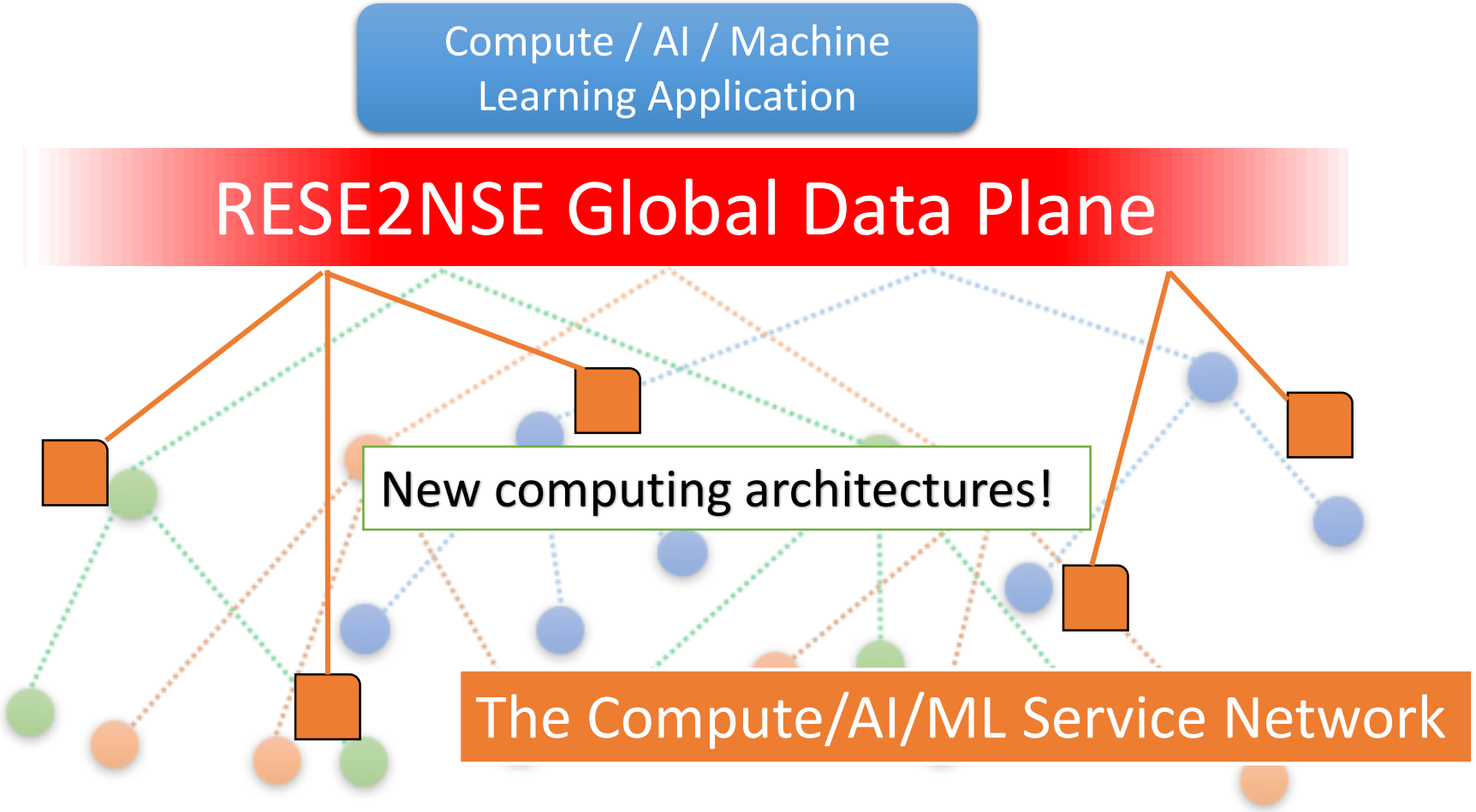
Sensor Node + GDP Deployment at UP EEEI

What do we do with all that **DATA**?

Extract **ACTIONABLE** Information!



Intelligence as a **SERVICE**



- **Dedicated nodes** for delivering computing & learning services
- **Can be shared by many networks**
- Reduces the node overhead required for intelligent and resilient operation

Man-made Attacks

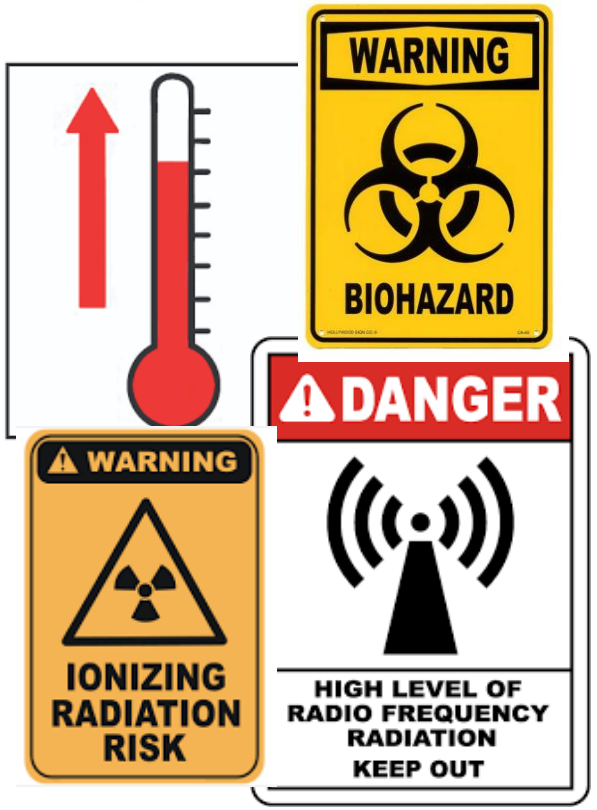
Energy-starved Operation

WARNING

Harsh & Adversarial Environment

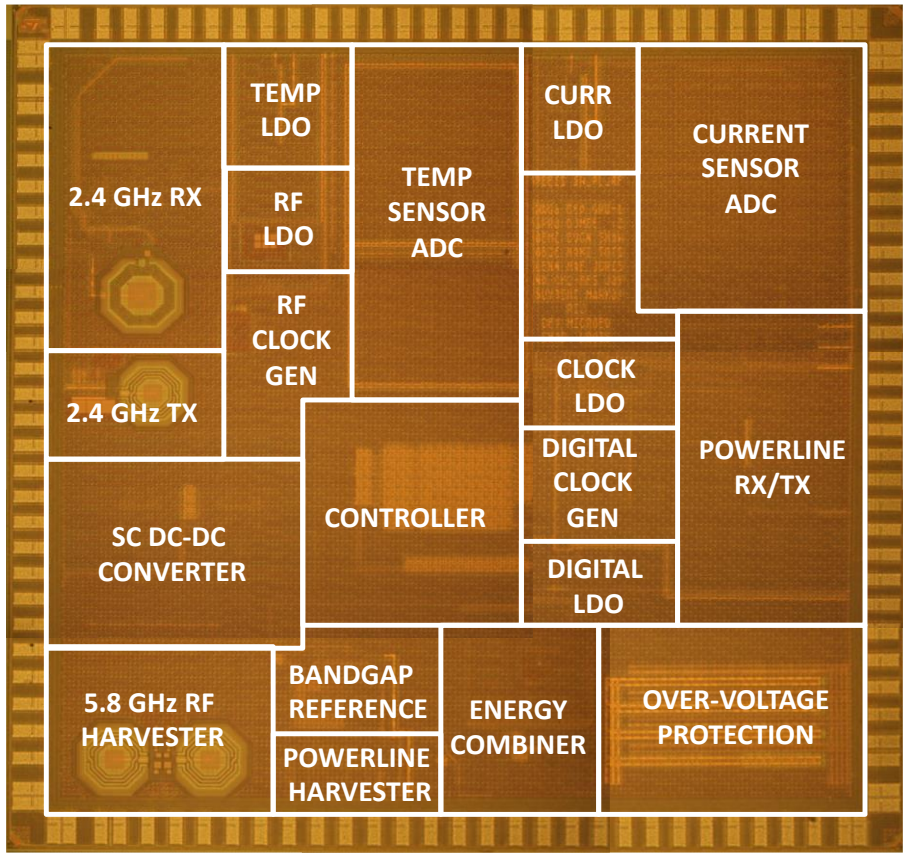
Natural Disasters

Extreme Environmental Conditions

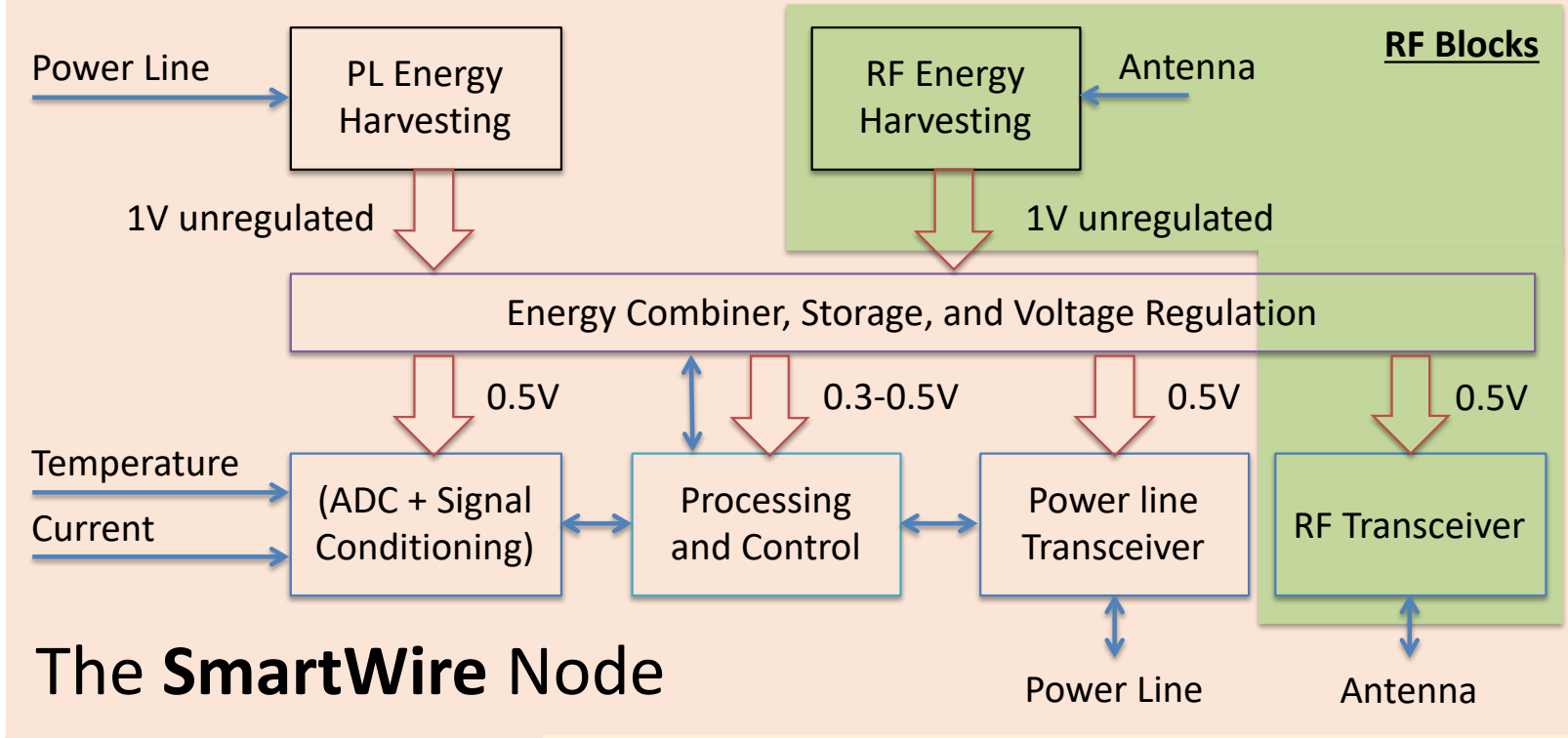


Resiliency = Redundancy

Energy Harvesting (2)

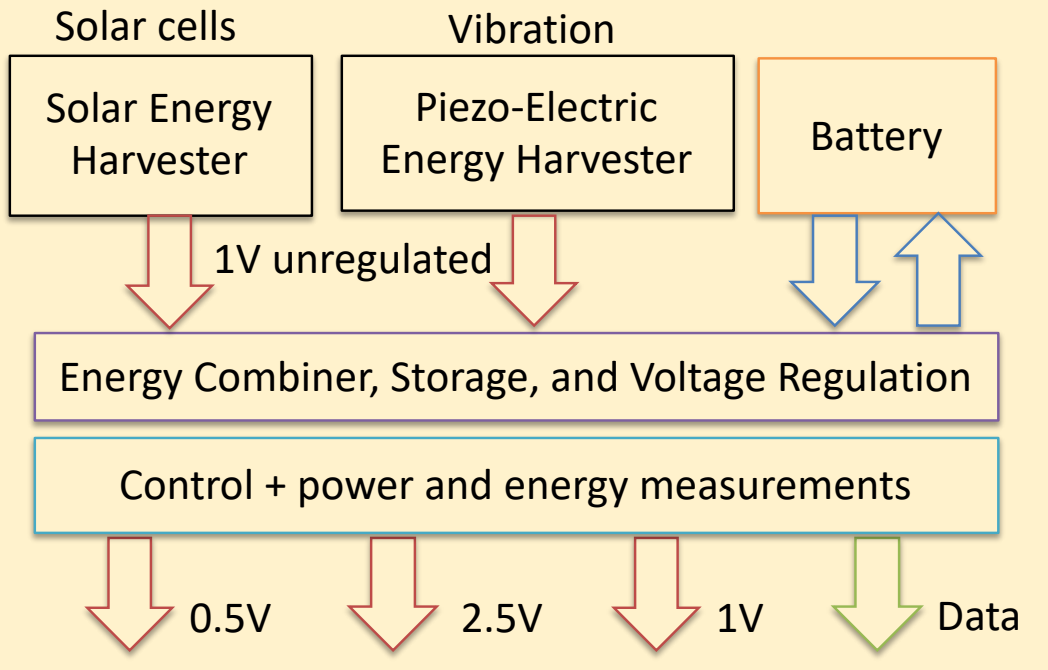


3mm x 3mm 65nm CMOS
SmartWire Sensor Node



The **SmartWire** Node

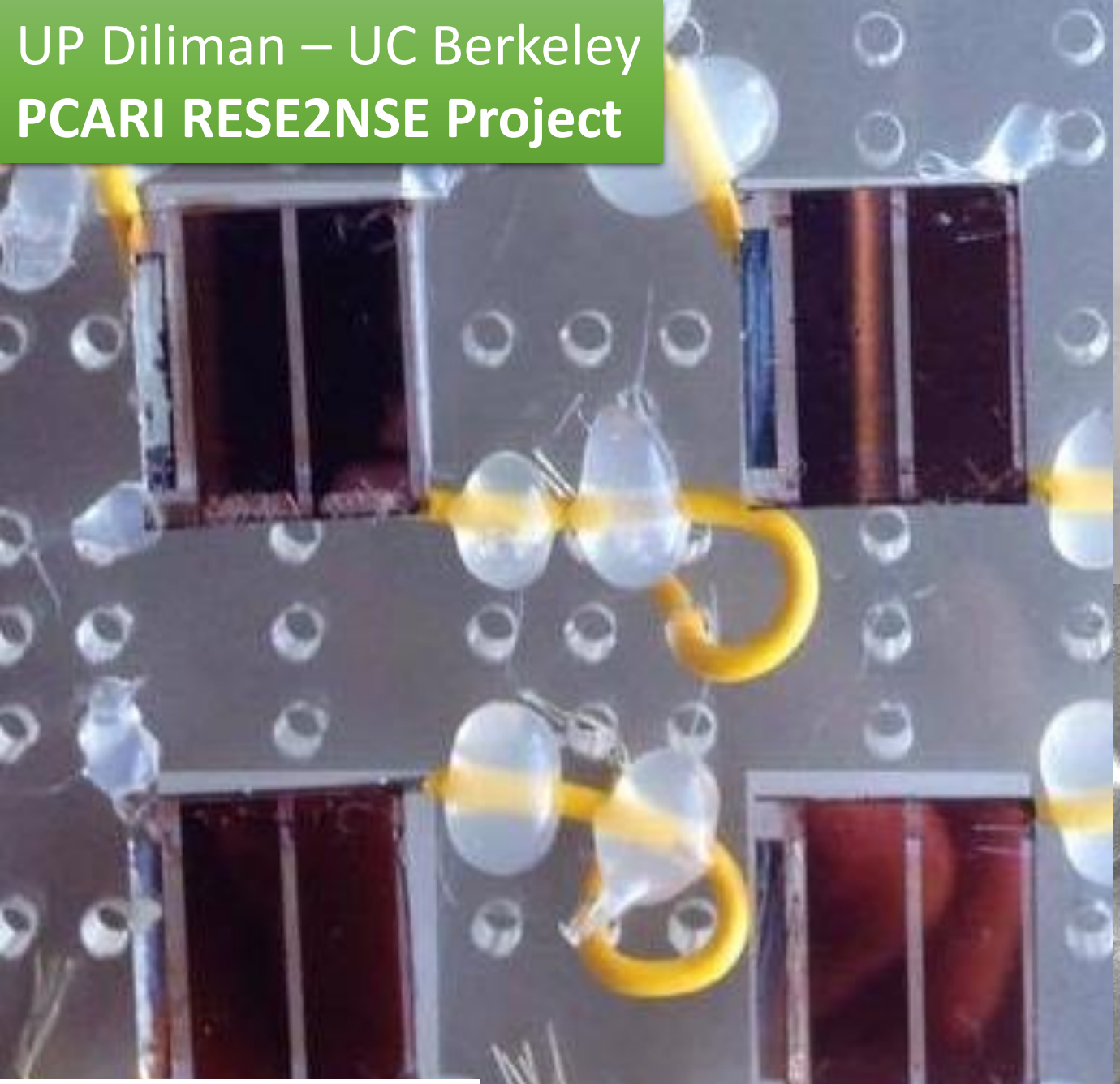
The **RESE2NSE** Power Management Integrated Circuit



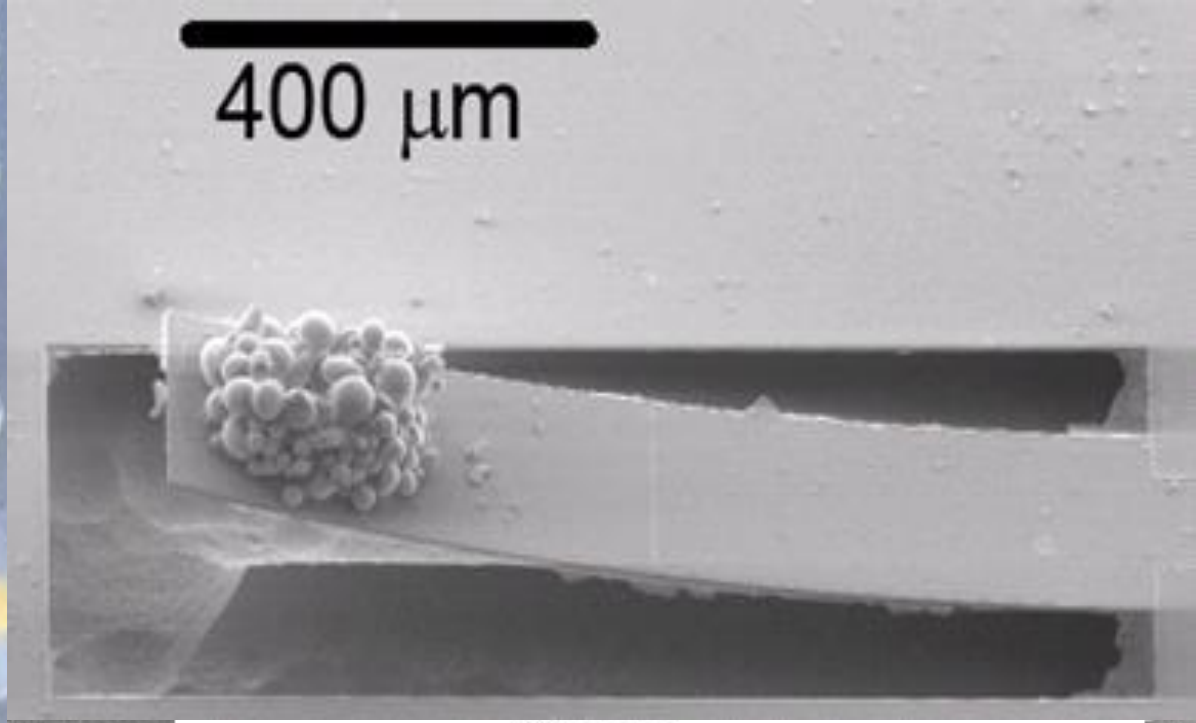
Multi-Source Energy Harvesting

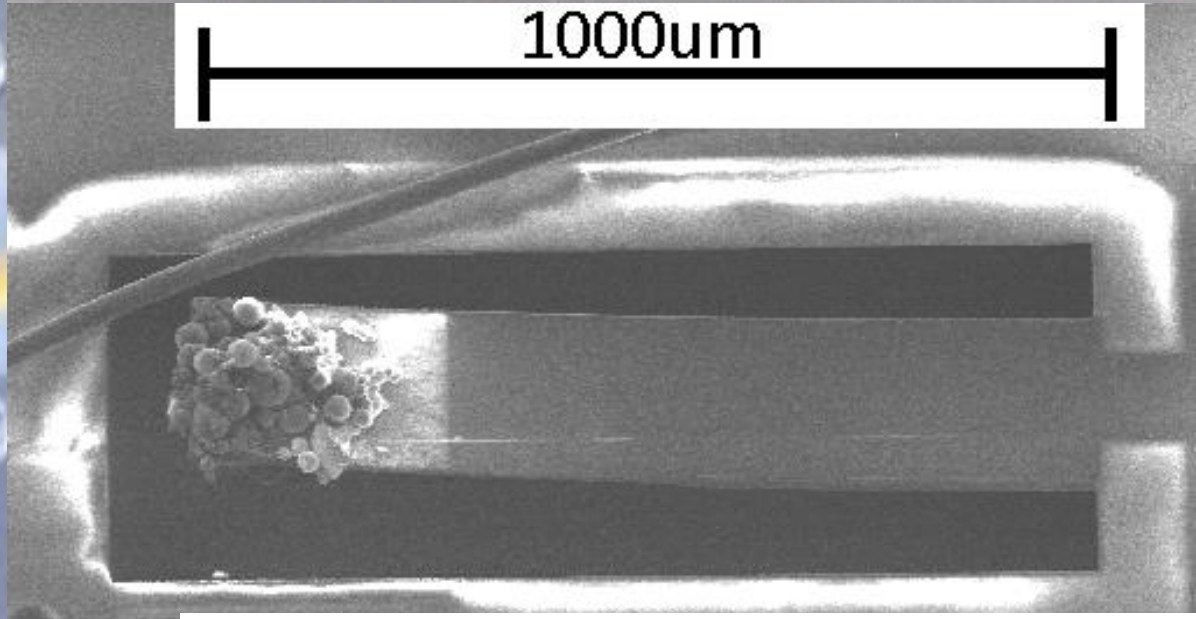
UP Diliman – UC Berkeley

PCARI RESE2NSE Project



Printed Solar Cells



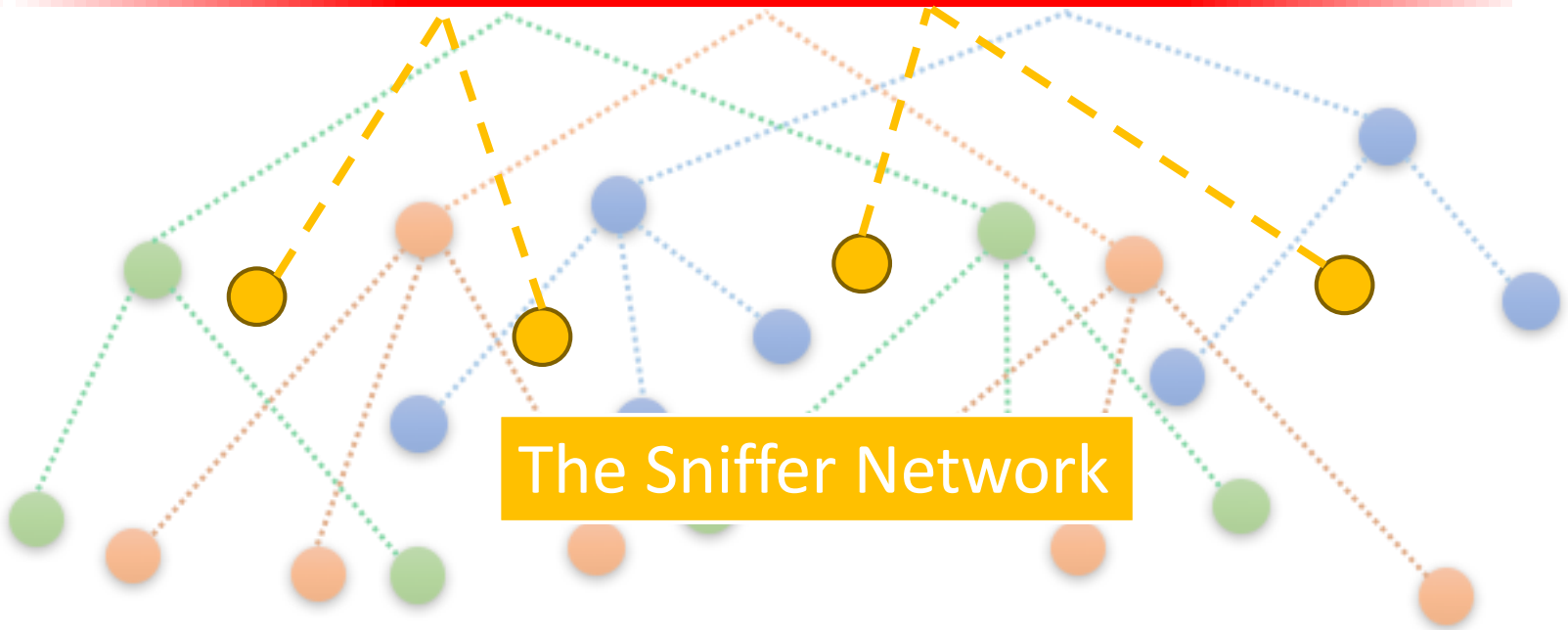


Piezo-electric Energy Harvesters

Resiliency as a **SERVICE**

Network Resiliency Application

RESE2NSE Global Data Plane

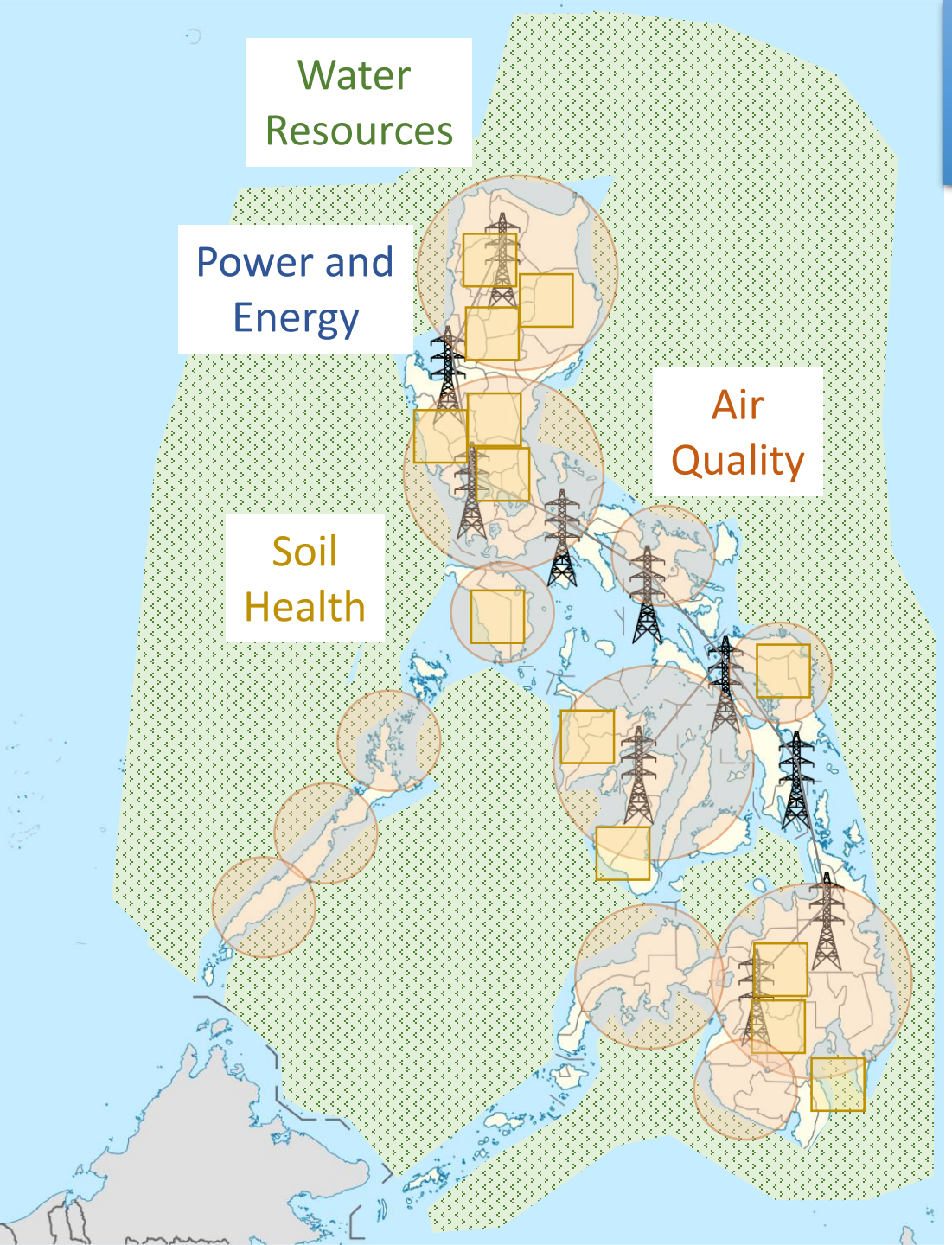


The Sniffer Network

Sensor + Network Data

Resiliency Models

Resilient Actuation and Feedback



Large-Scale Systems:
Building The Trillion-Node Network

1 Zero-Maintenance

Energy Harvesting, Low-Power Electronics

2 Scalable

GDP, AI/ML Integration

3 Resilient

Cost of Redundancy in all components

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