

# Making the Case for Plug & Sense<sup>SM</sup> Networks

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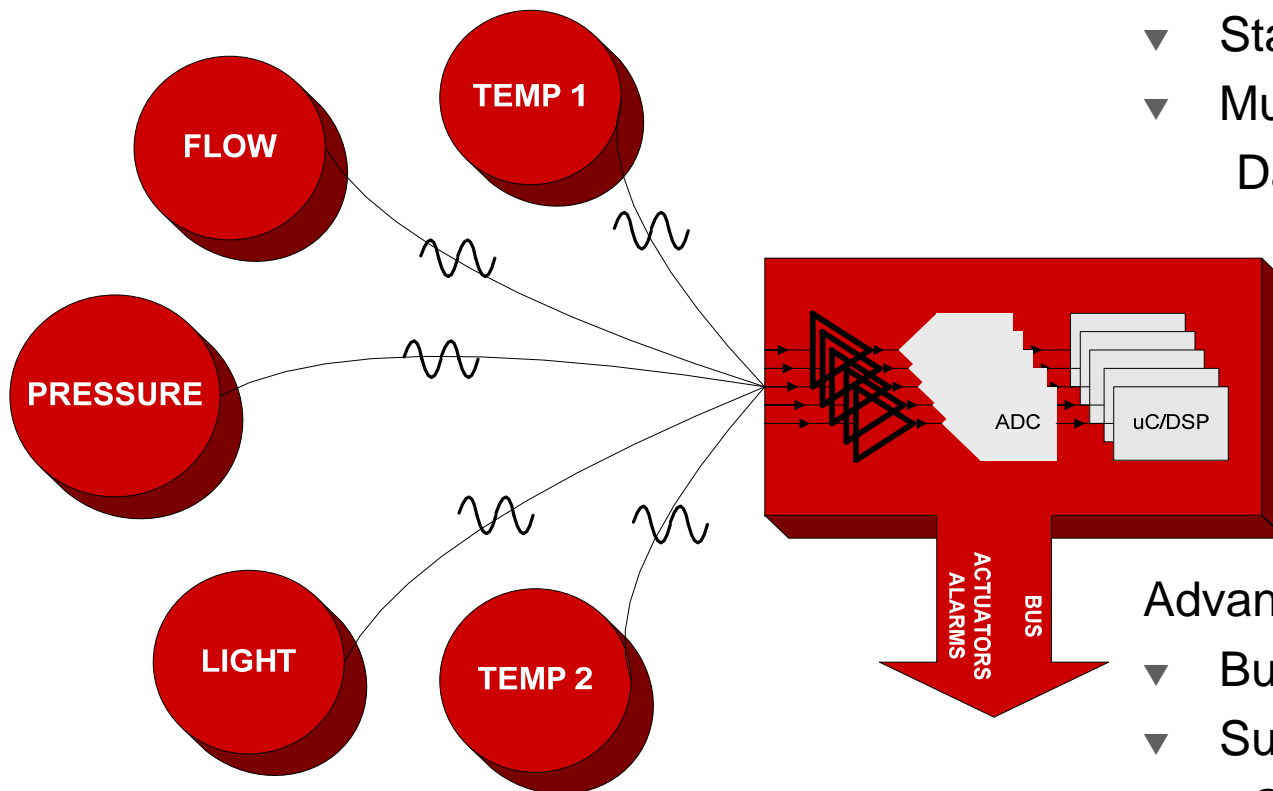
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***We Connect the REAL World to the Digital World™***

- ▼ **Macro Trends**
- ▼ **Classic Sensor Network Architecture**
- ▼ **Plug & Sense Network Architecture**
- ▼ **Node Block Diagram**
- ▼ **Performance Criteria**
  - **Signal Processing**
  - **Calibration/Serialization**
  - **Communications**
    - ▼ **Wired**
    - ▼ **Wireless**
- ▼ **Applications Examples**
- ▼ **Summary**

- ▼ **High Density Mixed Signal Integration**
  - **Monolithic Sensor Systems on Chip**
    - ▼ **Analog, Digital, Memory, Non-Volatile Memory**
  - **MEMS**
- ▼ **Low Power Silicon Technologies**
  - **Sub-threshold CMOS Design**
  - **130nm, 90nm, 45nm CMOS & SOI**
- ▼ **Wireless Mesh Networking Protocols**
  - **Adaptive, Redundant, Self-Healing, Low Power**
  - **Zigbee, UWB, WiBree, Wireless HART, SP100, etc...**
- ▼ **Simple, Powerful RISC Processors & OS**
  - **MSP430, AVR, TinyOS, BlueCore, etc...**

# Classic Sensor Network Architecture

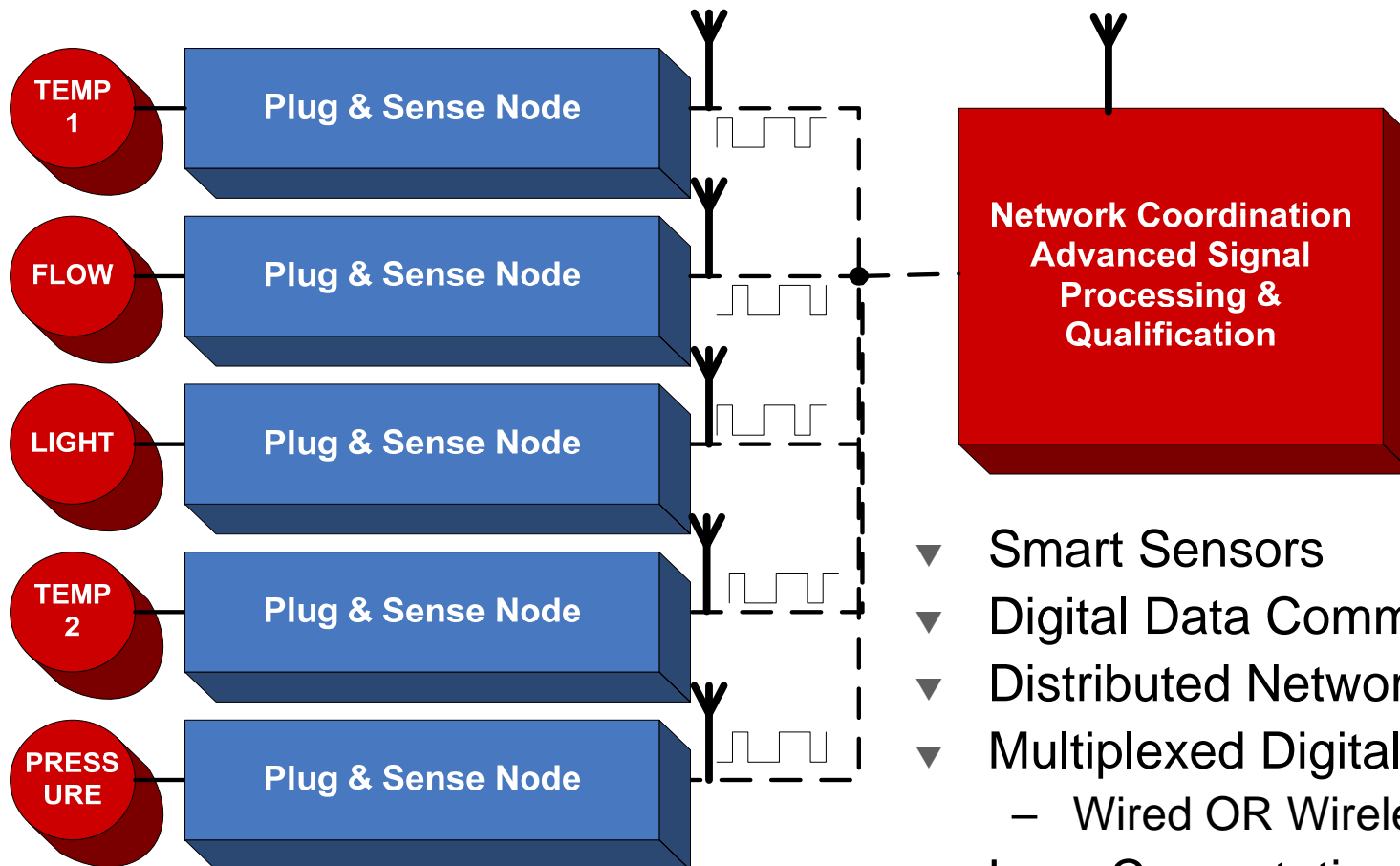


- ▼ Analog Sensors
- ▼ Star Connected
- ▼ Multiplexed (or Concurrent) Data Conversion

## Advanced Networks :

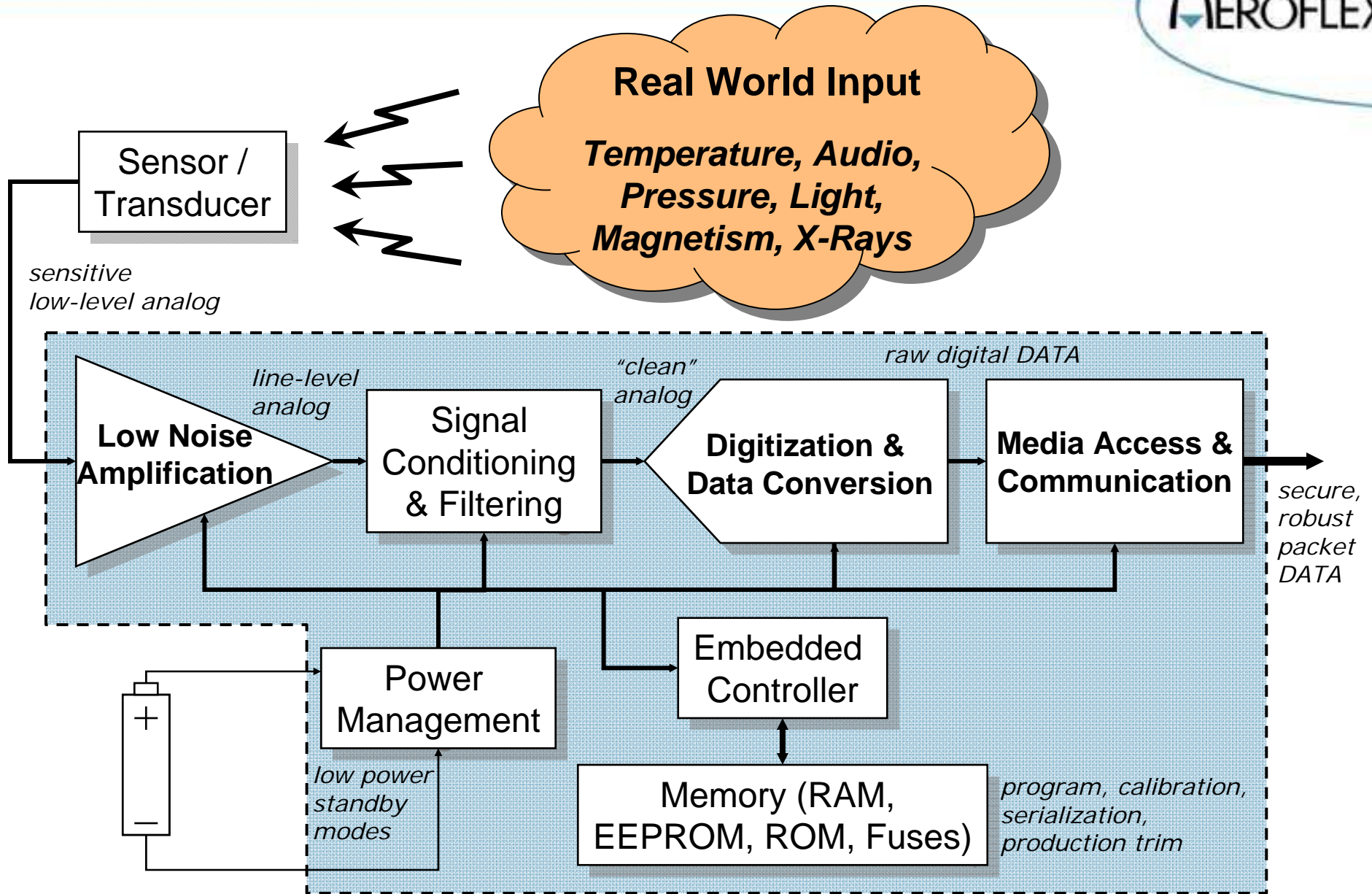
- ▼ Bus Digital Data
- ▼ Superimpose Digital Data Over Analog

# Plug & Sense Network Architecture



- ▼ Smart Sensors
- ▼ Digital Data Communications
- ▼ Distributed Network Intelligence
- ▼ Multiplexed Digital Bus
  - Wired OR Wireless
- ▼ Less Computation-Intensive Network Controller

# Plug & Sense Node Block Diagram



# Performance Criteria

- ▼ **Optimized Complete Sensing System**
  - Amplify, Digitize, Communicate
- ▼ **Lowest Power Consumption**
  - Battery Life → “Harvested” Energy
- ▼ **Powerful Signal Processing**
  - Low Noise Signal Conditioning
  - High Resolution Digitization/Data Conversion
  - Analog & Digital Filtering
  - Simple Data Qualification
    - ▼ Alarms/Interrupts
    - ▼ Data Collection/Reduction
- ▼ **Configurable**
  - Linearization/Calibration
    - ▼ Correct Offset, Gain & Nonlinearities
  - Serialization/Identification
    - ▼ Unique ID, Network ID, Lot #, etc...
- ▼ **Reliable Communications (Wired or Wireless)**
  - Latency
  - Data rate
  - Reliability

# Body Sensor Networks

## ▼ Uses

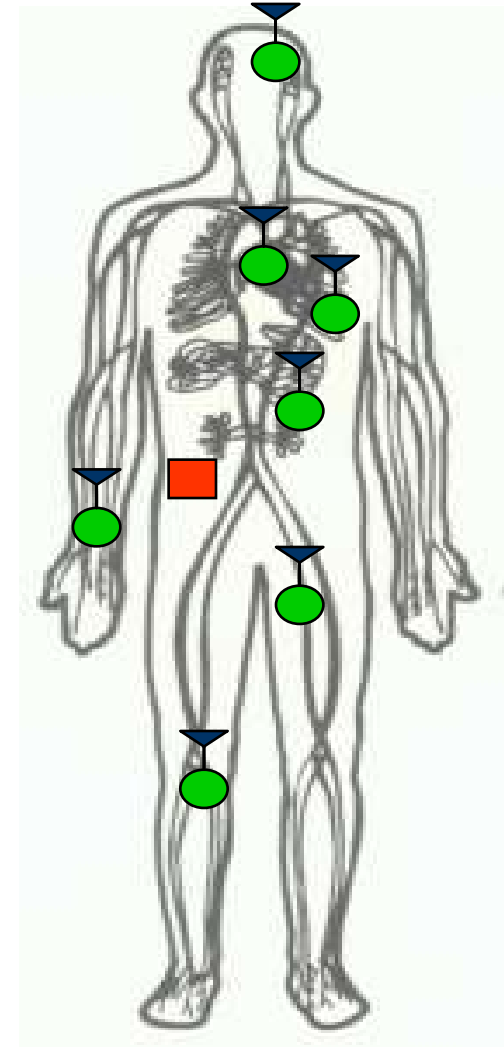
- Clinical, Home & Hospital Patient Monitoring
- Recreational/Fitness Monitoring

## ▼ Benefits

- Portability
- Performance
- Ease of Use

## ▼ Challenges

- Differential Measurements
- Low Signal to Noise
- Very Small Signals
- FDA Approval



# Unattended Ground Sensors

## ▼ Uses

- Ubiquitous Surveillance
- Autonomous Reconnaissance
- Soldier Health Monitoring
- Asset Location

## ▼ Benefits

- Safer Data Collection
- Better Intelligence
- Less Manpower Required

## ▼ Challenges

- Environmental Ruggedness
- Small Size/Portability
- Battery Life
- Large Number of Nodes
- Communications Range & Reliability

# And the Winner Is.....

- ▼ **Sensor Network Needs are Very Diverse**
  - **Sensor Characteristics**
  - **Data Resolution**
  - **Node Lifetime**
  - **Communications Protocol**
    - ▼ **Latency, Range, Data rate, Reliability**
  - **Size Requirements**
  - **Node DSP Requirements**
  
- ▼ **Optimized for One is Compromised for Another**
  
- ▼ **Numerous Solutions Will Find Significant Market Acceptance**

# Plug & Sense Summary

- ▼ **Efficiency/Cheap Data Storage Driving Ubiquitous Sensing Demand**
- ▼ **New Technologies Enabling “Smart Sensors”**
- ▼ **Distributed Network Intelligence**
  - Improves Signal Integrity
  - Minimizes Network Traffic
  - Improves Reliability
- ▼ **Tradeoffs Must Be Made**
  - Power
  - Latency
  - Reliability
  - Resolution