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Basics of IIoT:

Industrial Sensing & Actuation

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Introduction

- **IoT** deployment in **Industry** (IIoT)
- **Sensor**: Primary source of IIoT data, Big analog/digital data
- **Intelligence** of IoT is developed based on sensor data
- **Actuator**: Follow control decision

Need of Sensing for Industry

- Higher degree of automation
- Raise Productivity
- Improve Quality
- Better Safety
- Reduced Downtime

Requirements for Industrial Standard

- Reliable Sensing
- Low cost sensing and actuation
- Perpetual sensor and actuation network connectivity

Industrial Sensing

Conventional Sensing

- Involved in feedback automation of a process in industrial control system

- Based on sensing (feedback), further action is taken as per the application requirements

Industrial sensing (Contd.)

Contemporary Sensing

- Sensors connected to the Internet
- Can sense
  - Product lifetime
  - Loop efficiency
  - Safety
  - Reliability

Smart Sensor

“ Sensor with small memory and standardized physical connection to enable communication with the processor and data network ”

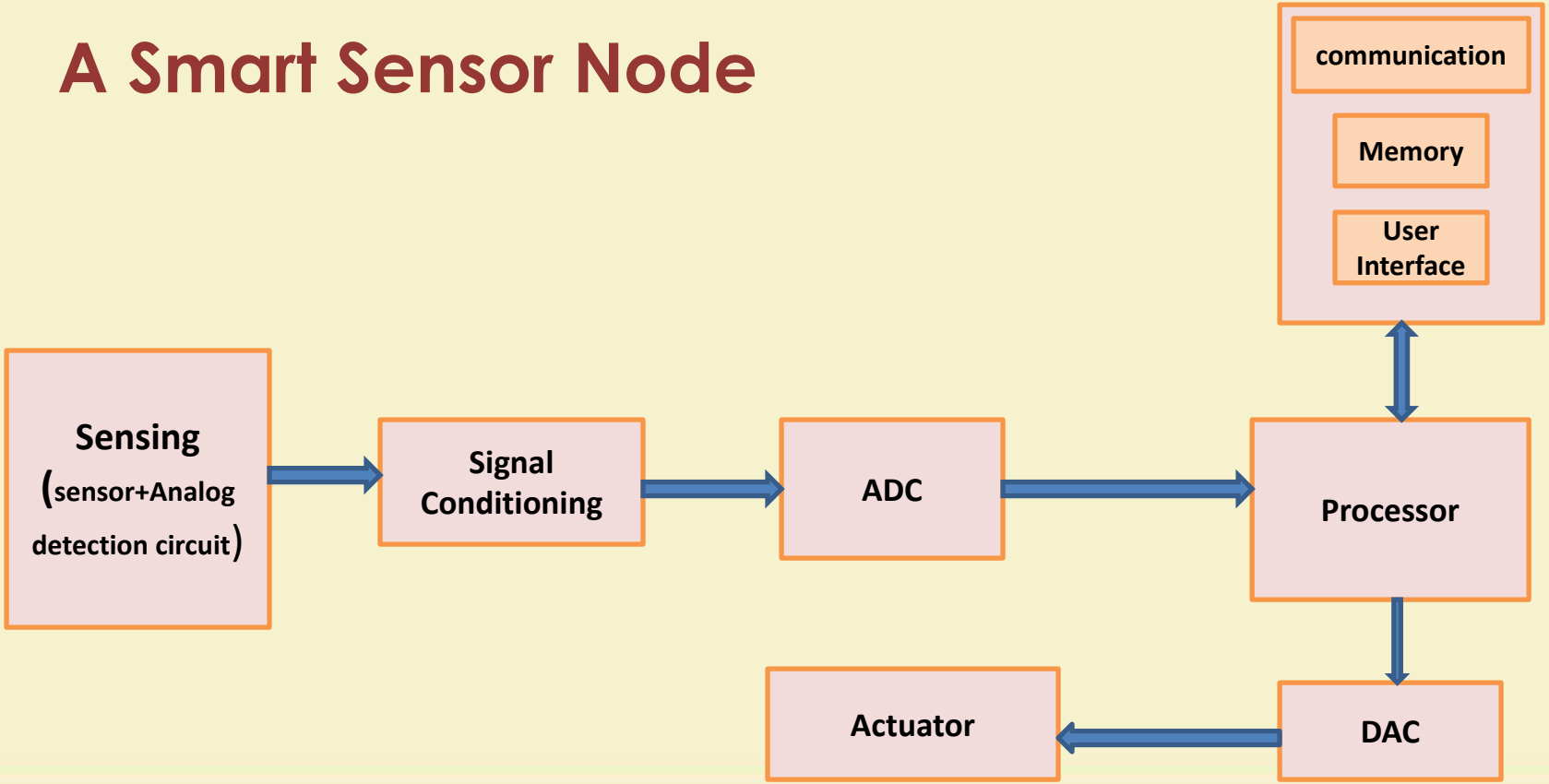
-defined by IEEE 1451 standard

Configurations involved in Smart Sensors

- Multiparameter Sensing Unit
- Analog Detection Circuit
- Digital Signal Conditioning Unit
- Interfacing Unit to bus

Source: T. Islam, S. C. Mukhopadhyay and N. K. Suryadevara, "Smart Sensors and Internet of Things: A Postgraduate Paper," in *IEEE Sensors Journal*, vol. 17, no. 3, pp. 577-584, 1 Feb.1, 2017

A Smart Sensor Node



Smart Sensor Functions

- Smart sensors can perform multiple functions
  - **Multisensing:** It can sense multiple parameters (temperature, pressure, light, humidity etc) at a single sensor node, which may help in the deciding factors in production unit of an industry
  - **Communicate data:** Communicating vital information like measured, callibration and compensation data to the Central control unit
  - **A/D or D/A Conversion:** The Analog data needs digital conversion to apply several signal processing methods for having reliable and accurate data

Smart Sensor Function (Contd.)

- **Self-Decision Making:** It can self-monitor its operation and changes in the ambience by taking proper decision for required compensation by itself or by alerting human for required action
- **Reduced Cost** : Cost continues to reduce as investment is recovered by reduced downtime in industries

Illustrating Sensing in Milk Packaging Unit

- Install sensor in line with the outlet tap
- Sensor contain impellers inside
- Impeller spins when milk moves
- Sends electrical signal to the control unit
- Controller interprets amount of liquid flow and stops when threshold is reached

Accessing Sensors & Actuators

- **Supporting OS** — Zephyr , Ubuntu , Opensuse , Ublinux , Archlinux , Androidthing

- **Programming Language** — C , C++ , Java , Python , Lua

Intel IoT Device Library used by sensors

MRAA

- Low-level skeleton library for communication in GNU/Linux platform
- Not hardware specific
- Better level of abstraction

UPM

- High level APIs for easier connectivity to sensors
- Easier to control
- Supporting industrial grade sensor

Source: " mraa 1.9.0" , Intel

Utility in Industrial Sub-Units

- Measurements
- Production
- Product Inspection
- Packaging & Shipping

Industrial Sensor Calibration

- It is the method adopted to improve the performance of the sensing system by readjusting and removing the error in the measured response of the sensor compared to the actual response
- Industrial grade sensors use highly complex signal processing algorithm and onboard circuitry to take care of calibration.

Industrial Sensor Calibration (Contd.)

- Calibrate in system to be used
- Standard references
- Proper calibration methods
- Re-calibration

Examples of Industrial sensors

- **Navigation industry** (Track sensors: GPS)
  - Spot significant places
  - Tracking real time object
  - Analyze traffics
  - Scanning at check post
  - Predict driver Destination

Examples of Industrial sensors (contd.)

- **Agriculture Industry** (Smart sensors)
  - Soil and water sensor, Weather tracking, RFID technology, Optical sensors
  - For accurate use of fertilizers and determining crop health; Crop sensors
  - Best time to plant crop
  - Remote monitoring
  - Agbots; To automate agricultural processes

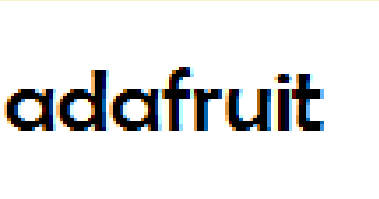
Examples of Industrial sensors (contd.)

- **Health Care Industry**
  - Implantable sensors, MEMS ,biosensors, nano sensors
  - Smart pills
    - Pills sends alert message to other members when swallowed
    - Camera pills for imaging
  - Smart bed
    - Use sensors that prevent fall of the patient and sends report about the patient's movement

Examples of Industrial sensors (contd.)

- **Retail Industry**
  - RFID tracking chip
  - Tracking location of shipment made possible with GPS and IoT
  - Sensors on shopping cart and product to avoid theft

Sensors Technology Manufacturers



PLC: Industrial Applications

- Programmable Logic Controller (PLC) is
  - special computer device used in industrial automation systems
  - special-purpose digital computer in industries.
- Architecture of PLC
  - **CPU module:** consists of central processor and memory.
    - Central processor-performs the computations and processes data
    - Memory –stores the programs and data
  - **Power supply module:** supplies power to the entire circuitry
  - **I/O module:** connects the sensors and actuators.

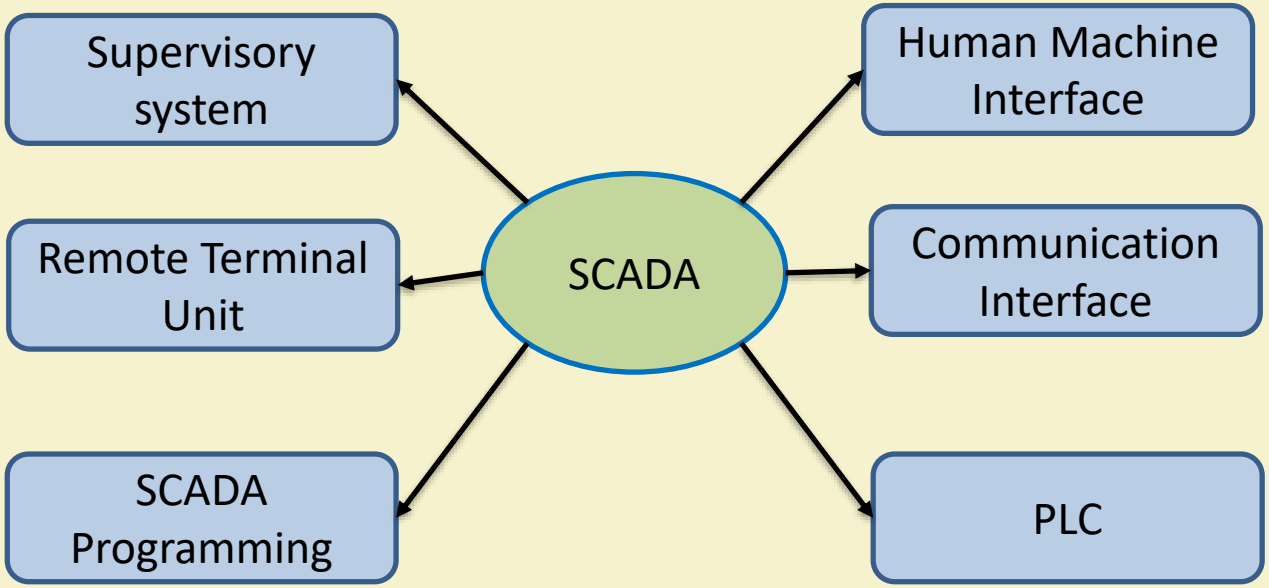
Source: edgefx.in

SCADA: Industrial Applications

- Supervisory control and data acquisition (SCADA) is
  - an **industrial control system**
  - process, monitor, and analyze data at the same time
  - used to collect data from remote sites and transmit data to a central site.
  - applicable for process, oil, power generation, energy, water and waste control, and manufacturing industries.

Source: edgefx.in

SCADA: Industrial Applications (contd.)



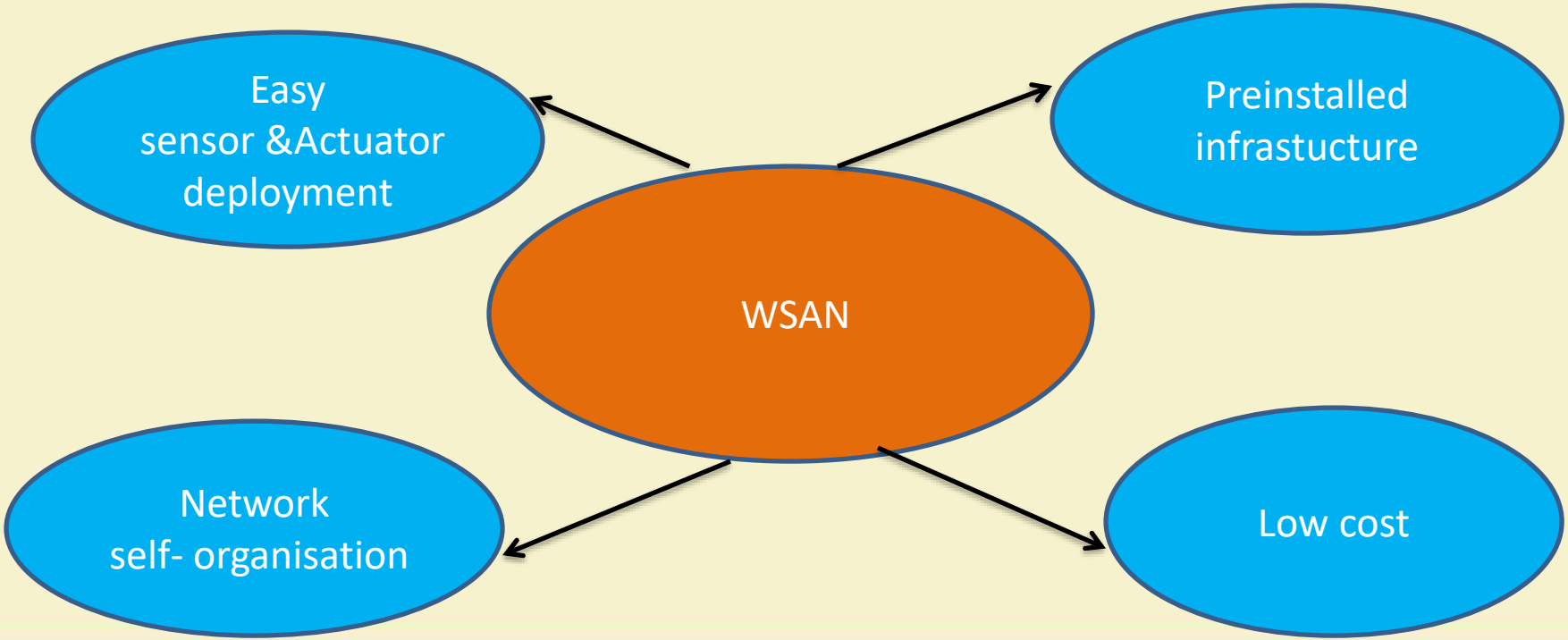
Source: edgefx.in

Industrial control with WSANs

- Industrial Monitoring and control are made easier with WSANs (Wireless Sensing & Actuation Network)
- "Integration of sensors and actuators with wireless network protocol, Real time task scheduling and control law form a WSAN"
  - HVAC control system in industries employ wireless sensor in order to measure temperature
  - Actuation depends on the controllers treatment on the sensors measurement
  - In HVAC control system Actuator can be an wireless air conditioner

Source: Distributed Collaborative Control for Industrial Automation With Wireless Sensor and Actuator Networks, *IEEE Transactions on Industrial Electronics*

WSANs Advantages



Electro-hydrostatic Actuation System

- A Substitute to traditional hydraulic and elecromechanical actuators
- Combined advantage of electric and hydraulic actuators
- High force capability
- High energy efficiency
- Decentralized Actuation

Source: Electrohydraustatic Actuation System , MOOG

Electro-pneumatic systems

- Precise flow control
- Advanced communication
- Better diagnostics
- Ultra high resolution
- Combine advantage of Electric and Pneumatic actuators

Source: Industrial pneumatic actuators ,Bray commertial

Actuators Technology Manufacturers

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Thank You!!