Robotics and Security Issues in Marine & Maritime Environmental Monitoring

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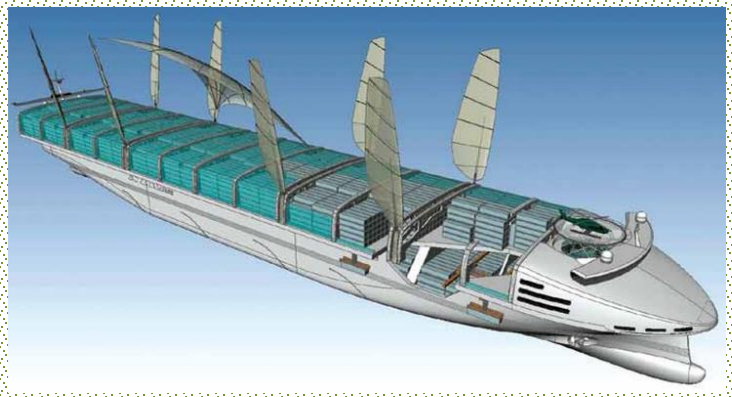
Contents

- Introduction
- Embedded Systems
- Internet of Things (IoT)
- Robot Vehicles
- Proposed System
- Conclusions

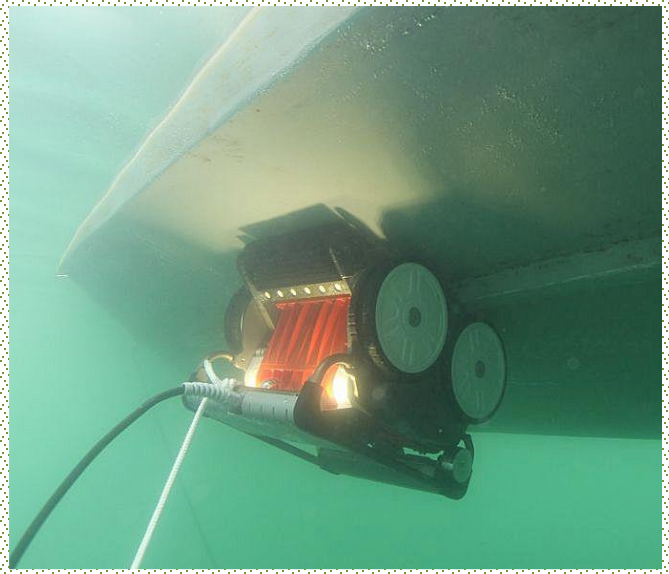
Safer and Greener Shipping

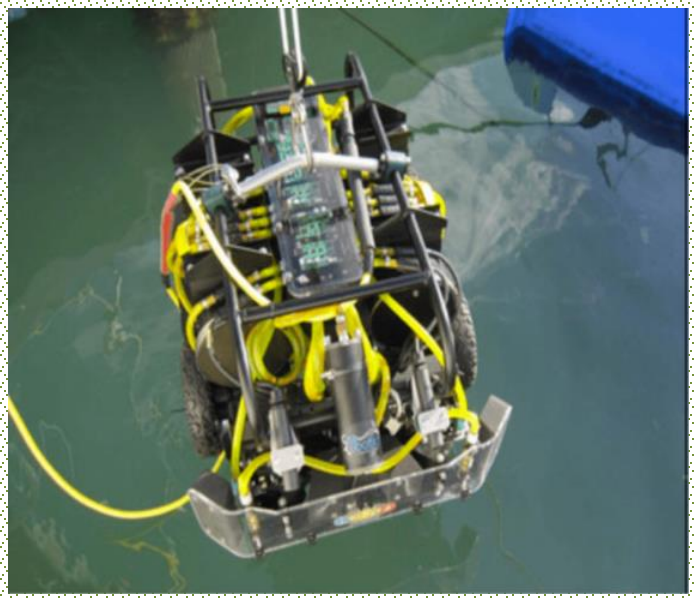
- Sustainable transport is recognized as one of the biggest challenges today
- It is recognized that whilst shipping is relatively safe and clean, compared with other transport modes, the industry does have a significant impact on the environment



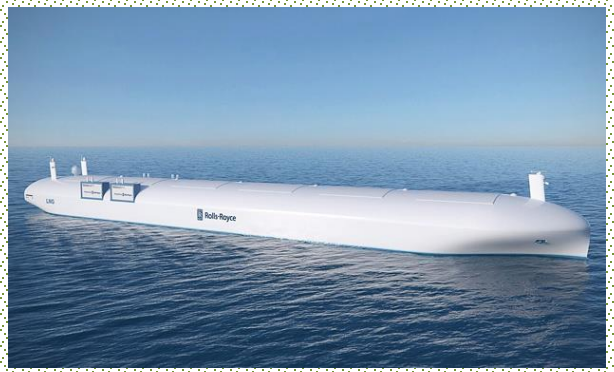

Marine Trends
SAFETY 2025
Goal based safety
REGULATIONS 2015
NOx
SOx
EEDI
REGULATIONS 2025
SOx
CO2
PARTICLE
2015
2025
HFO
LNG
HFO
OIL PRICE

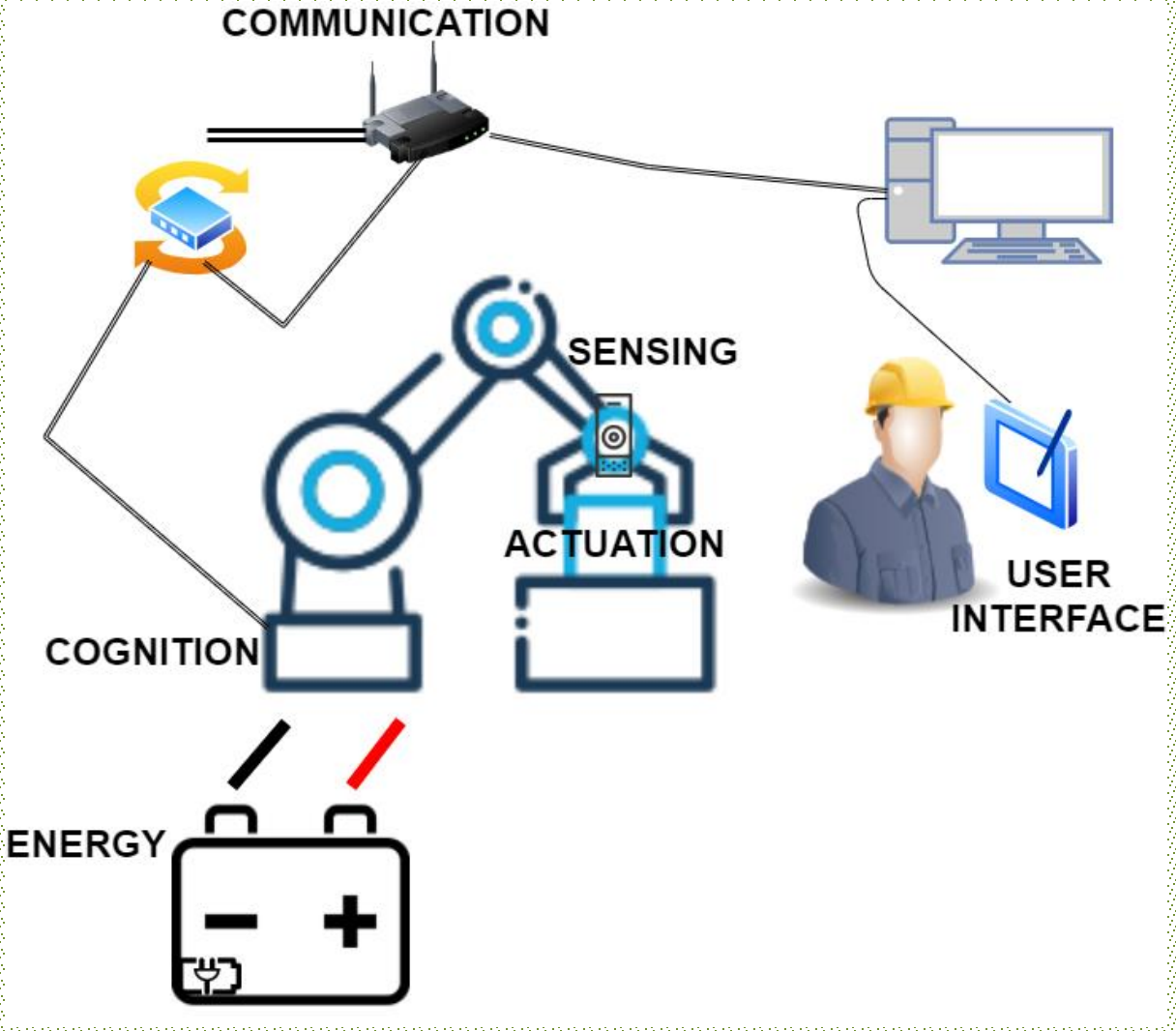
Marine Robotics

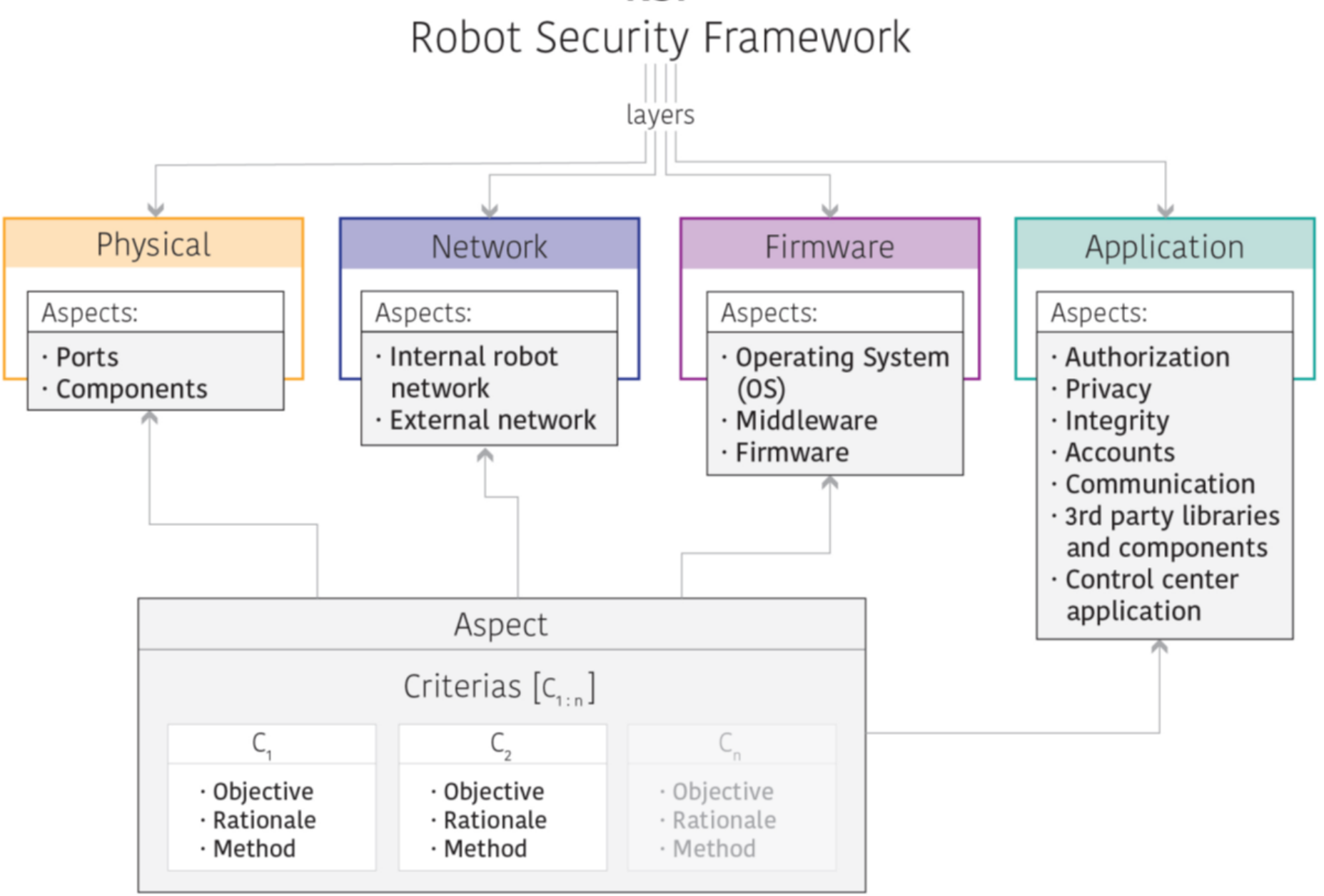


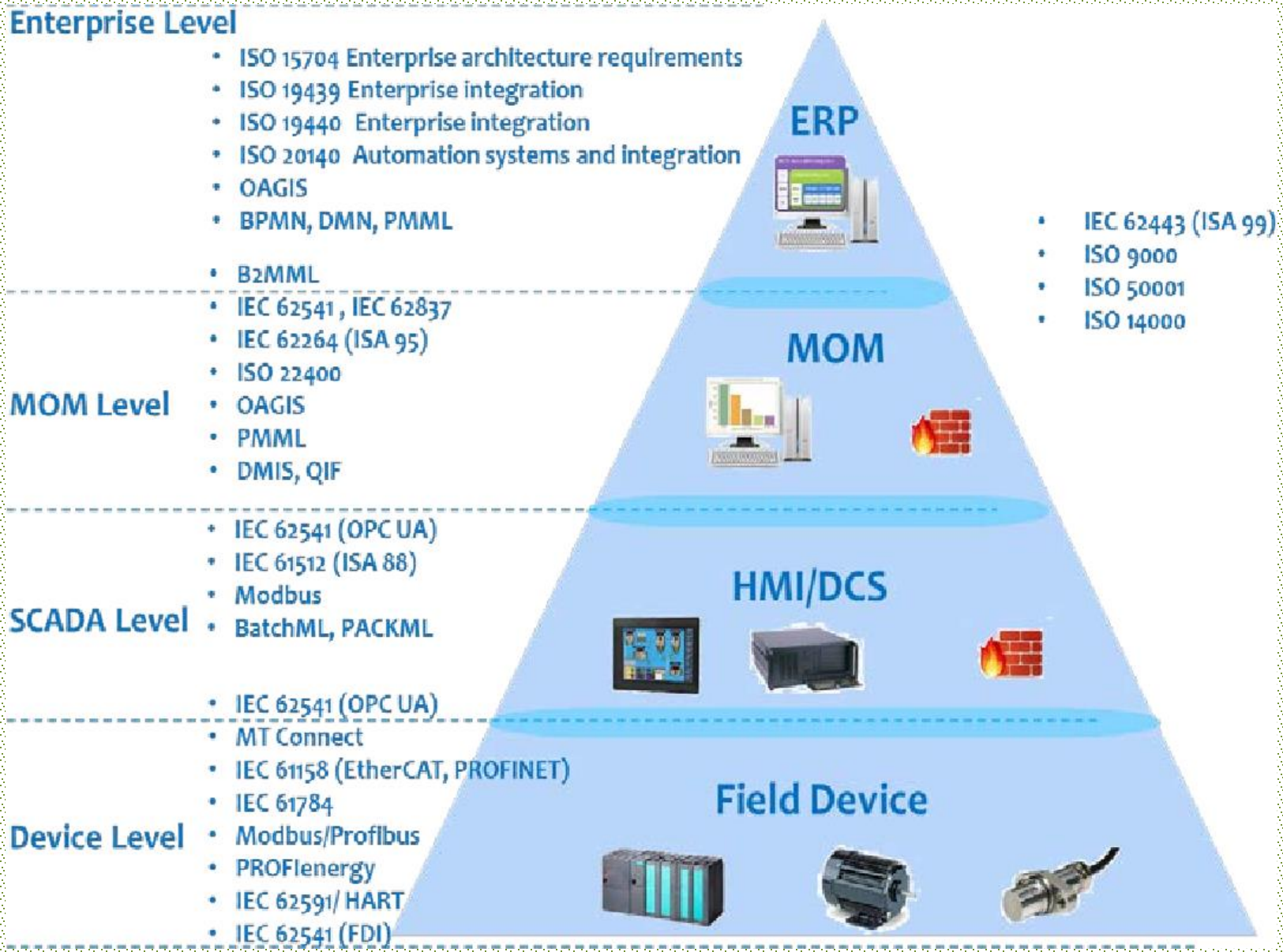



KEELCRAB
KEELCRAB

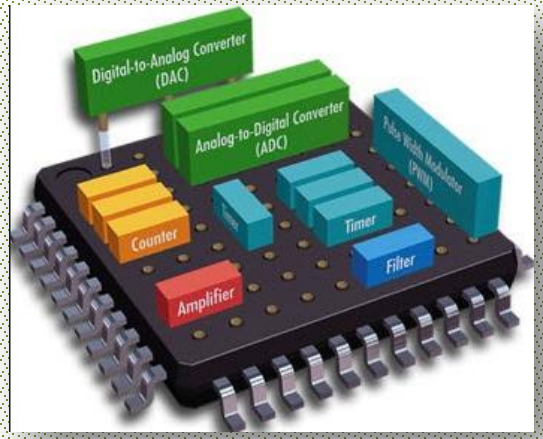

Rolls-Royce


COMMUNICATION
SENSING
ACTUATION
USER
INTERFACE
COGNITION
ENERGY

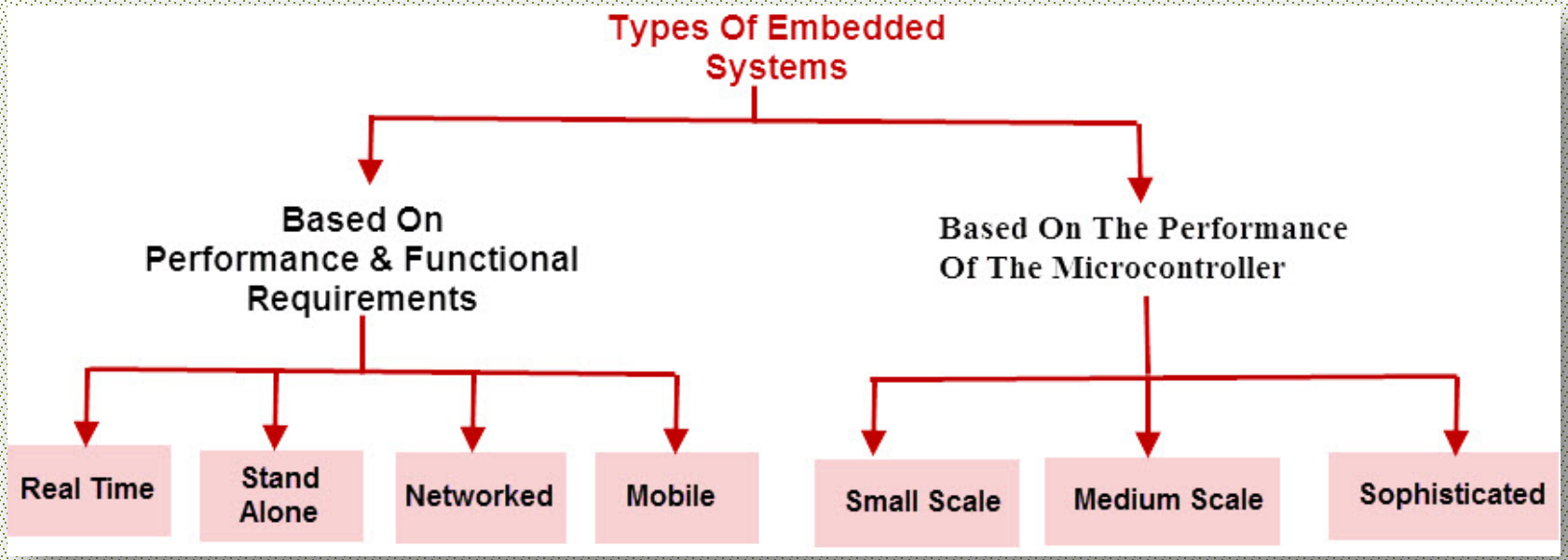

Robot Security Framework
layers
Physical
Aspects:
· Ports
· Components
Network
Aspects:
· Internal robot network
· External network
Firmware
Aspects:
· Operating System (OS)
· Middleware
· Firmware
Application
Aspects:
· Authorization
· Privacy
· Integrity
· Accounts
· Communication
· 3rd party libraries and components
· Control center application
Aspect
Criterias [C1:n]
C1
· Objective
· Rationale
· Method
C2
· Objective
· Rationale
· Method
Cn
· Objective
· Rationale
· Method


Enterprise Level
• ISO 15704 Enterprise architecture requirements
• ISO 19439 Enterprise integration
• ISO 19440 Enterprise integration
• ISO 20140 Automation systems and integration
• OAGIS
• BPMN, DMN, PMML
• B2MML
MOM Level
• IEC 62541 , IEC 62837
• IEC 62264 (ISA 95)
• ISO 22400
• OAGIS
• PMML
• DMIS, QIF
SCADA Level
• IEC 62541 (OPC UA)
• IEC 61512 (ISA 88)
• Modbus
• BatchML, PACKML
• IEC 62541 (OPC UA)
Device Level
• MT Connect
• IEC 61158 (EtherCAT, PROFINET)
• IEC 61784
• Modbus/Profibus
• PROFIenergy
• IEC 62591/ HART
• IEC 62541 (FDI)
ERP
MOM
HMI/DCS
Field Device
• IEC 62443 (ISA 99)
• ISO 9000
• ISO 50001
• ISO 14000

Embedded Systems

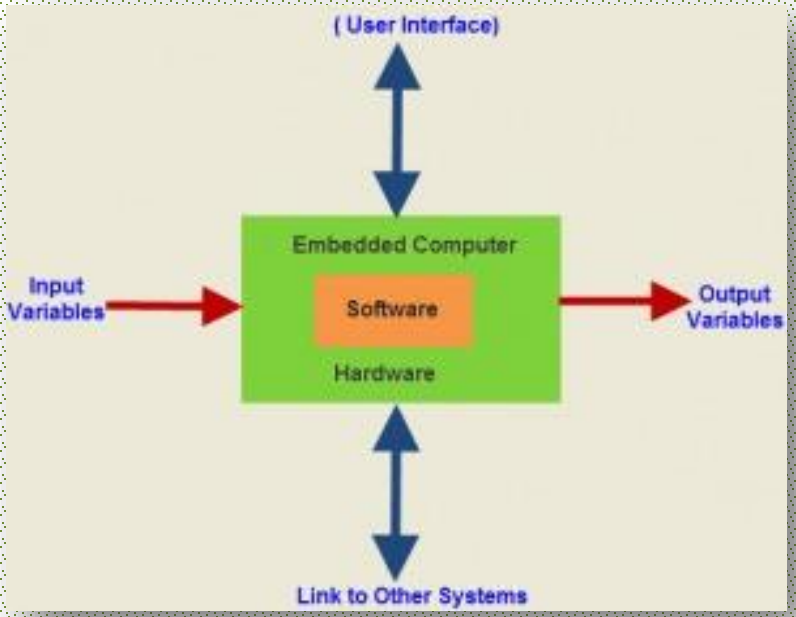


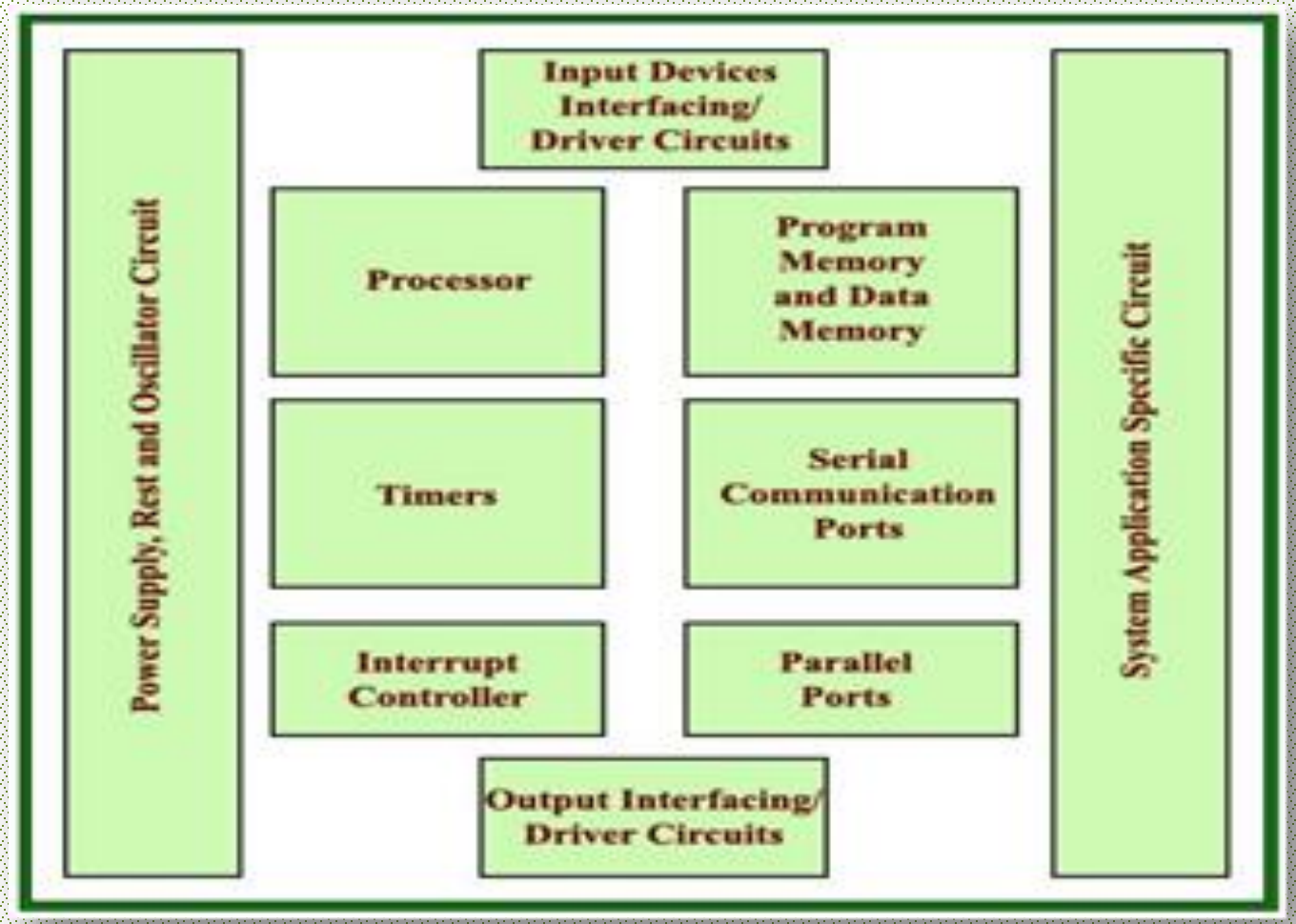
- The Embedded System (ES) is a computer system with a dedicated function within a mechanical or electrical system, often with real-time computing constraints
- It is embedded as part of a complete device often including hardware and mechanical parts
- , 90% of all microprocessors are manufactured as components of embedded systems


Types Of Embedded Systems
Based On Performance & Functional Requirements
Based On The Performance Of The Microcontroller
Real Time
Stand Alone
Networked
Mobile
Small Scale
Medium Scale
Sophisticated

The basic Characteristics of ES, must be dependable:

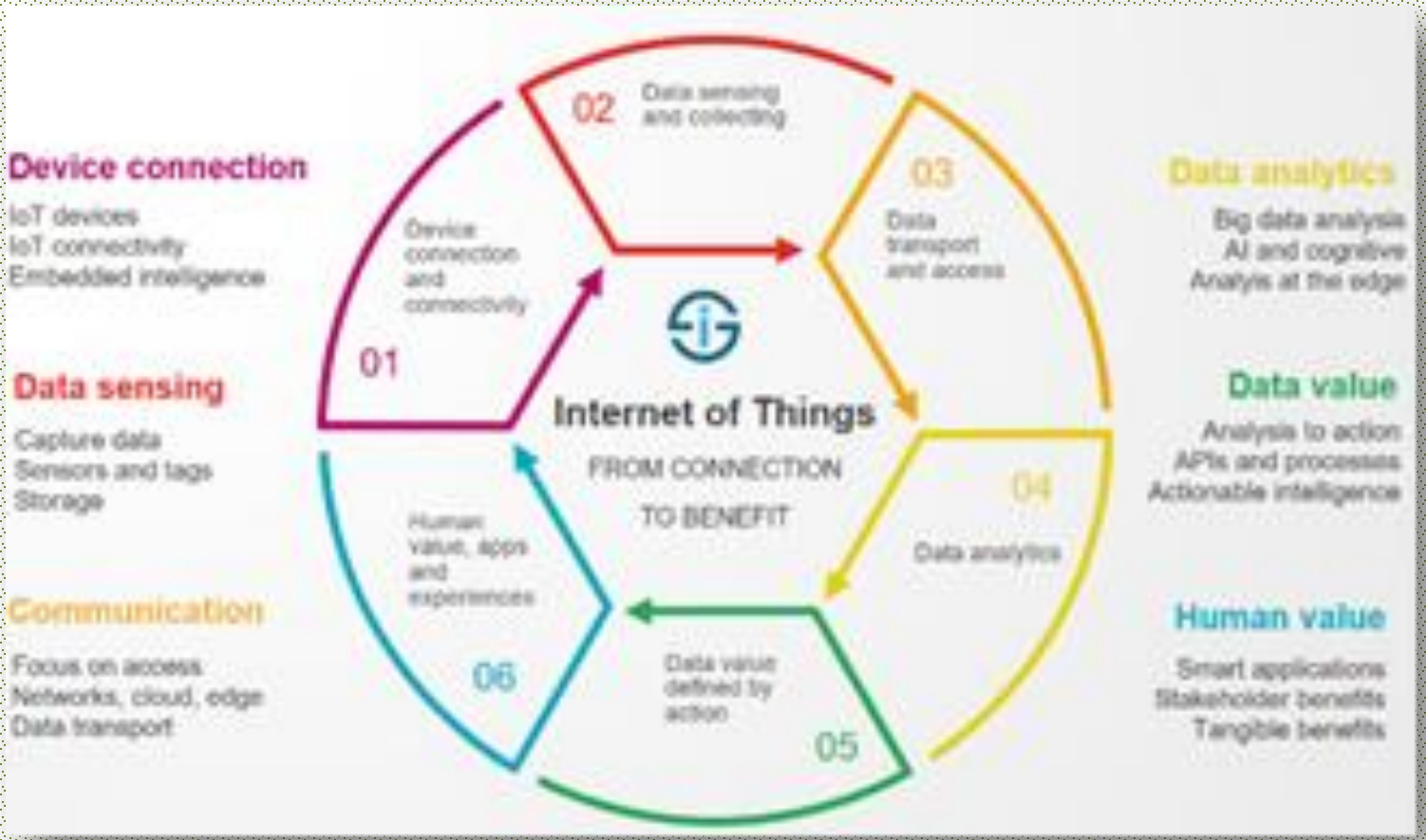
- Reliability
- Maintainability
- Availability
- Safety
- Security

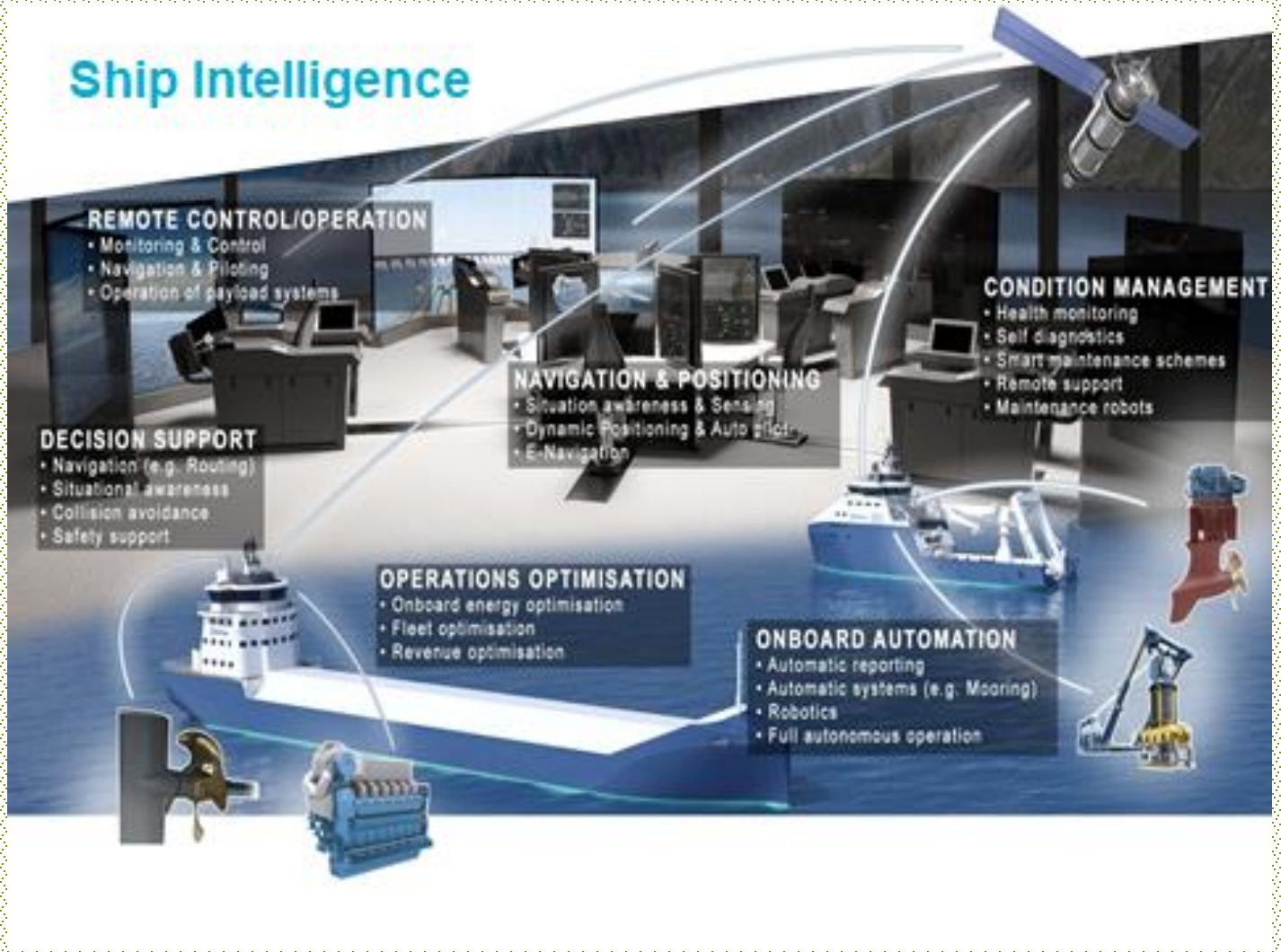



Power Supply, Rest and Oscillator Circuit
Input Devices Interfacing/ Driver Circuits
Processor
Program Memory and Data Memory
Timers
Serial Communication Ports
Interrupt Controller
Parallel Ports
Output Interfacing/ Driver Circuits
System Application Specific Circuit

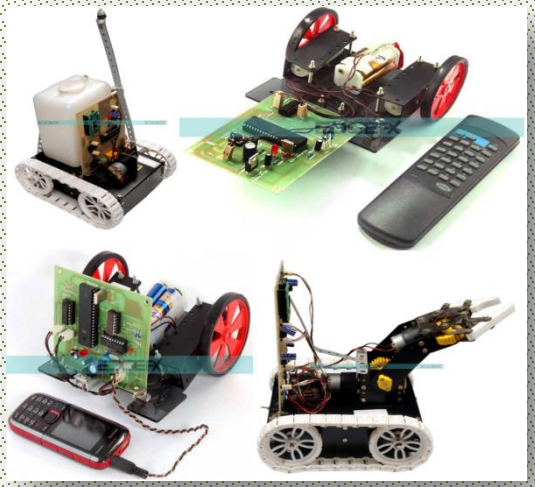
Internet of Things (IoT)

- IoT has evolved due to convergence of multiple technologies, including wireless communication, real-time analytics, machine learning, commodity sensors, and embedded systems
- IoT can be incorporated into environmental applications to produce dense and real-time maps of air and water pollution, noise level, temperature, and harmful radiation among others

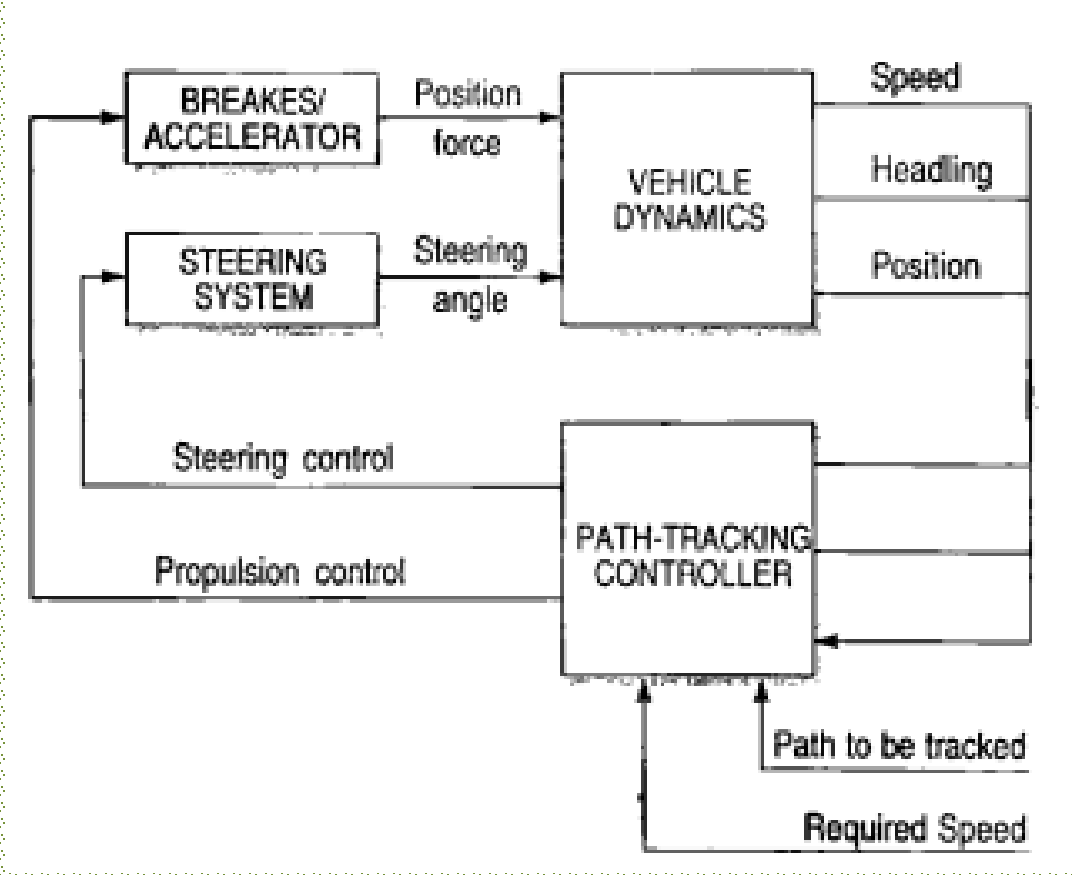

Device connection
IoT devices
IoT connectivity
Embedded intelligence
Data sensing
Capture data
Sensors and tags
Storage
Communication
Focus on access
Networks, cloud, edge
Data transport
01
Device connection and connectivity
02
Data sensing and collecting
03
Data transport and access
04
Data analytics
05
Data value defined by action
06
Human value, apps and experiences
Internet of Things
FROM CONNECTION
TO BENEFIT
Data analytics
Big data analysis
AI and cognitive
Analyis at the edge
Data value
Analysis to action
APIs and processes
Actionable intelligence
Human value
Smart applications
Stakeholder benefits
Tangible benefits


Ship Intelligence
REMOTE CONTROL/OPERATION
• Monitoring & Control
• Navigation & Piloting
• Operation of payload systems
NAVIGATION & POSITIONING
• Situation awareness & Sensing
• Dynamic Positioning & Auto pilot
• E-Navigation
CONDITION MANAGEMENT
• Health monitoring
• Self diagnostics
• Smart maintenance schemes
• Remote support
• Maintenance robots
DECISION SUPPORT
• Navigation (e.g. Routing)
• Situational awareness
• Collision avoidance
• Safety support
OPERATIONS OPTIMISATION
• Onboard energy optimisation
• Fleet optimisation
• Revenue optimisation
ONBOARD AUTOMATION
• Automatic reporting
• Automatic systems (e.g. Mooring)
• Robotics
• Full autonomous operation

Robot Vehicles

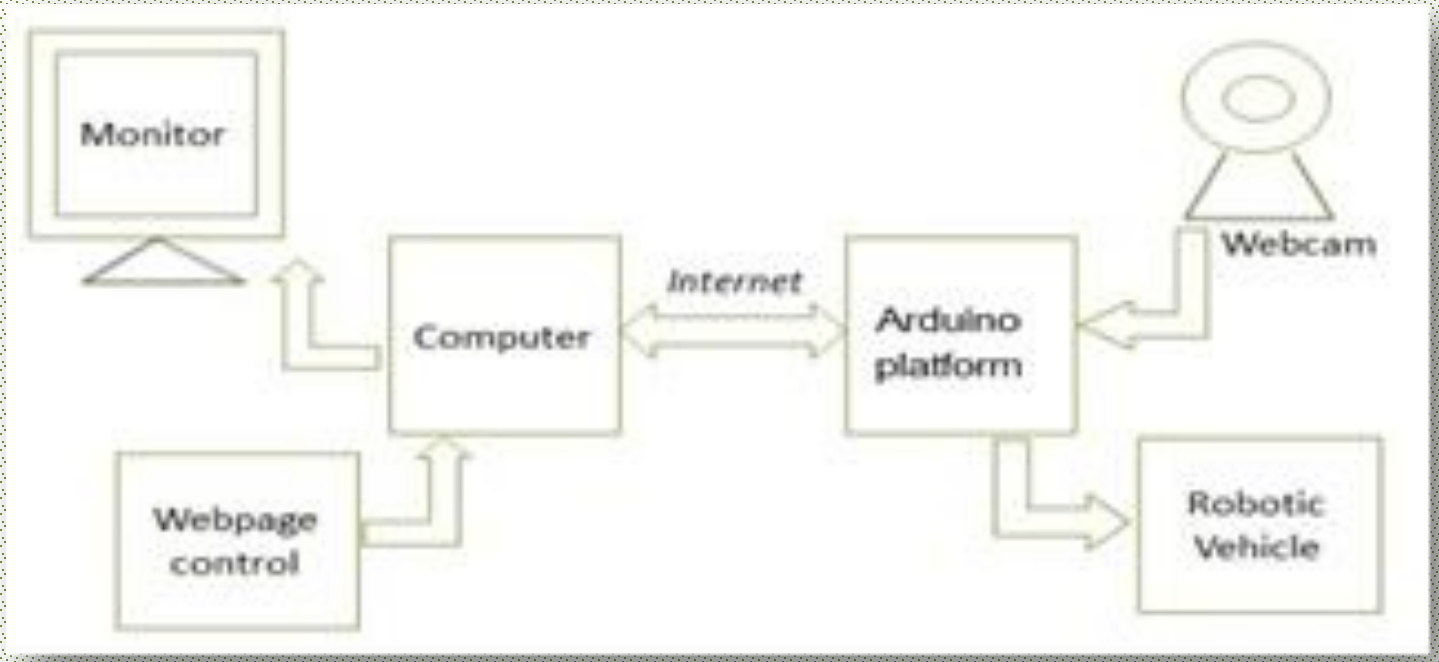


- The robotic vehicles can perform operations on unstructured and often hostile environment
- Important element in order to enable them to become useful for humans is the possibility of autonomy and hence autonomous navigation
- With the development of technology and cost reduction today it is possible to develop small robotic vehicles capable of operating autonomously using simple electronic devices

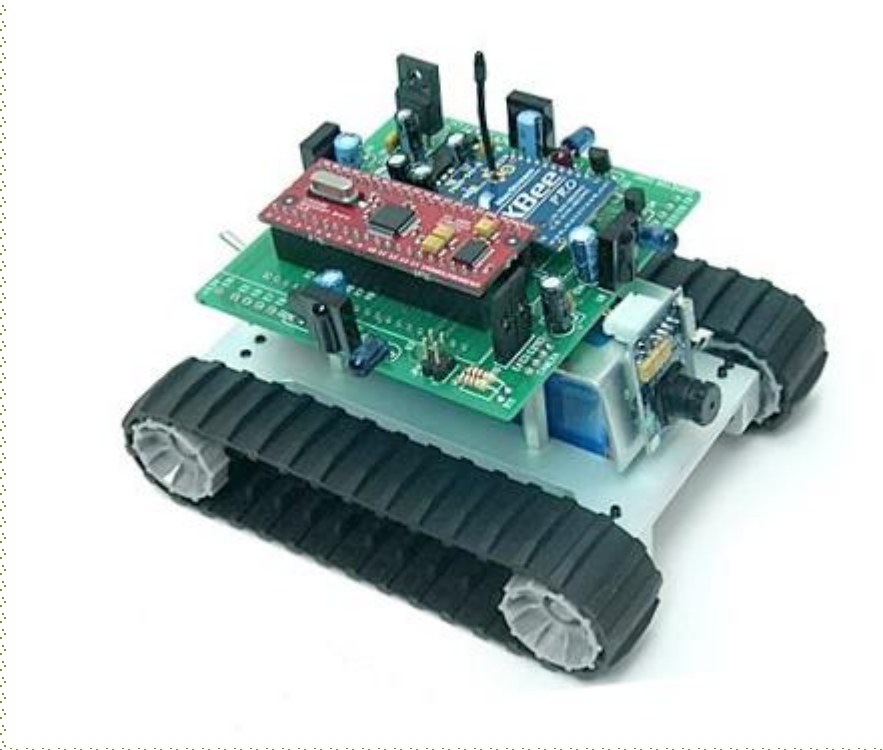


Principle of operation of a path-tracking controller

PROPOSED SYSTEM



The basic diagram of proposed system

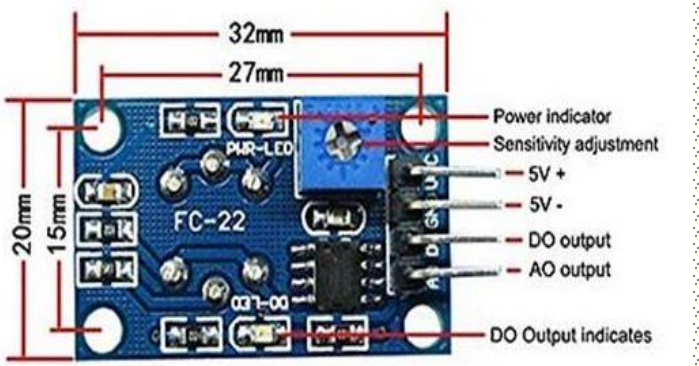

XBee
PRO

- by using internet (communication between the user and a robotic vehicle)
- controlled with PWM techniques using a Microcontroller and Bidirectional DC Bridge for Motor Driving (by using WiFi)
- Arducam MT9M001 web camera comes with a maximum resolution of 1280×1024 at 30 fps
- motor driver IC l293d used to power the DC motors (will be used to manoeuvre the robotic vehicle)

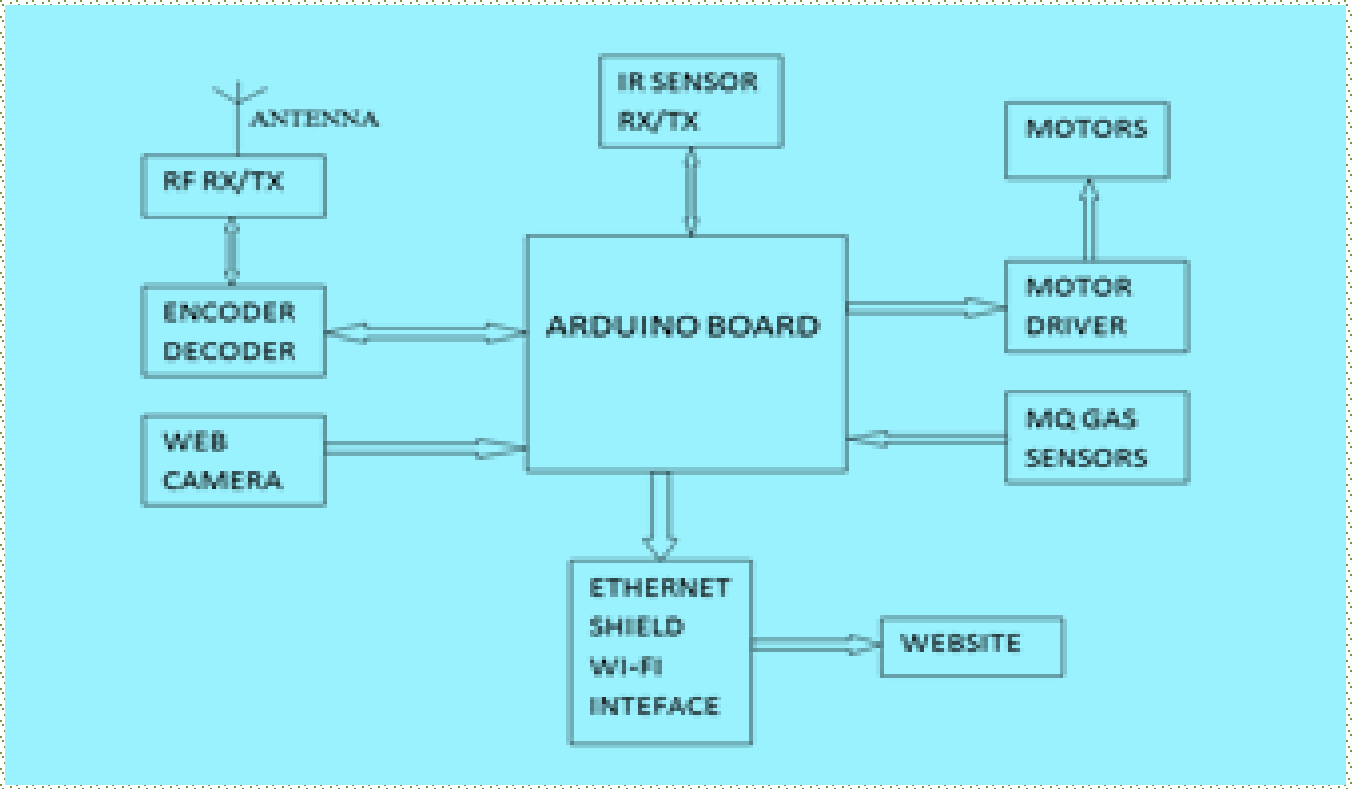
- An electronic nose (e-nose) system mimics the sense of smell and by using advanced chemo metric data analysis, an e-nose can perform diagnostics and predictions that are superior to what can be accomplished by the sense of smell

The hardware of MQ gas sensor has 4 pins:

- A0 Analog output
- D0 Digital output
- GND Ground
- Vcc Supply (5V)



- The RF transmitter circuit diagram is shown below is used to connect different push buttons to move the robotic vehicle in different directions like as forward, backward, right and left
- RF receiver is also being a small in size and RF receiver has supply current of 3.5mA with an operating voltage of 5V. RF transmitter modules are designed to work with 433MHz only



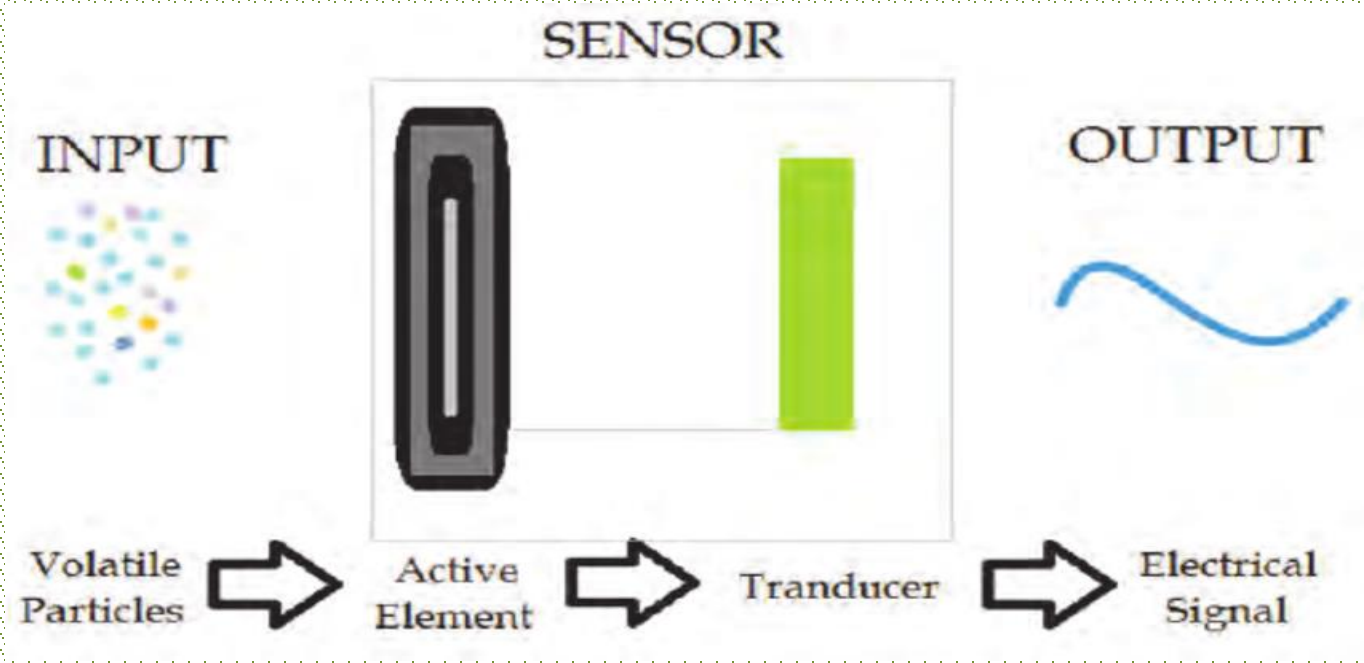
The basic RF transmitter circuit

List of Sensors included of this proposed system

MQ-2	Methane, LPG, Alcohol, Propane, Smoke
MQ-3	Alcohol, Ethanol, Smoke
MQ-4	Methane, CNG Gas
MQ-5	Natural Gas, LPG
MQ-6	LPG, butane
MQ-7	Carbon Monoxide
MQ-8	Hydrogen Gas
MQ-9	Carbon Monoxide, Flammable gasses

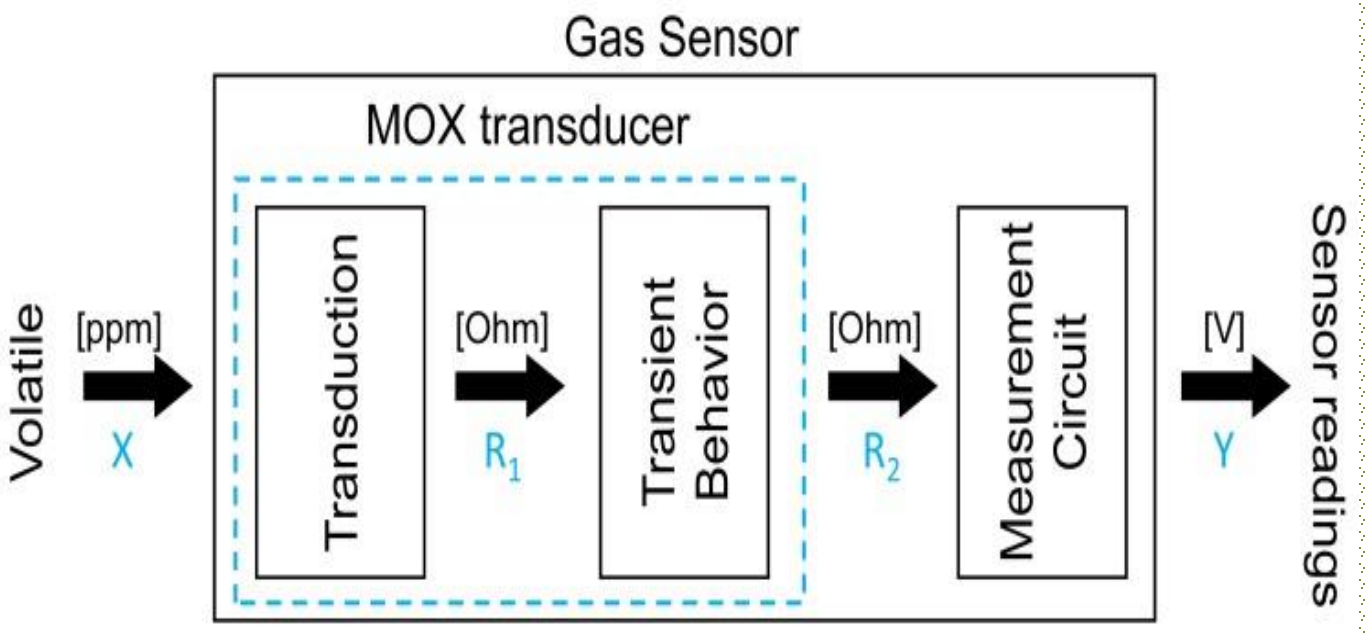
Popular MQ Series Gas Sensors

Schematic diagram of a gas sensor



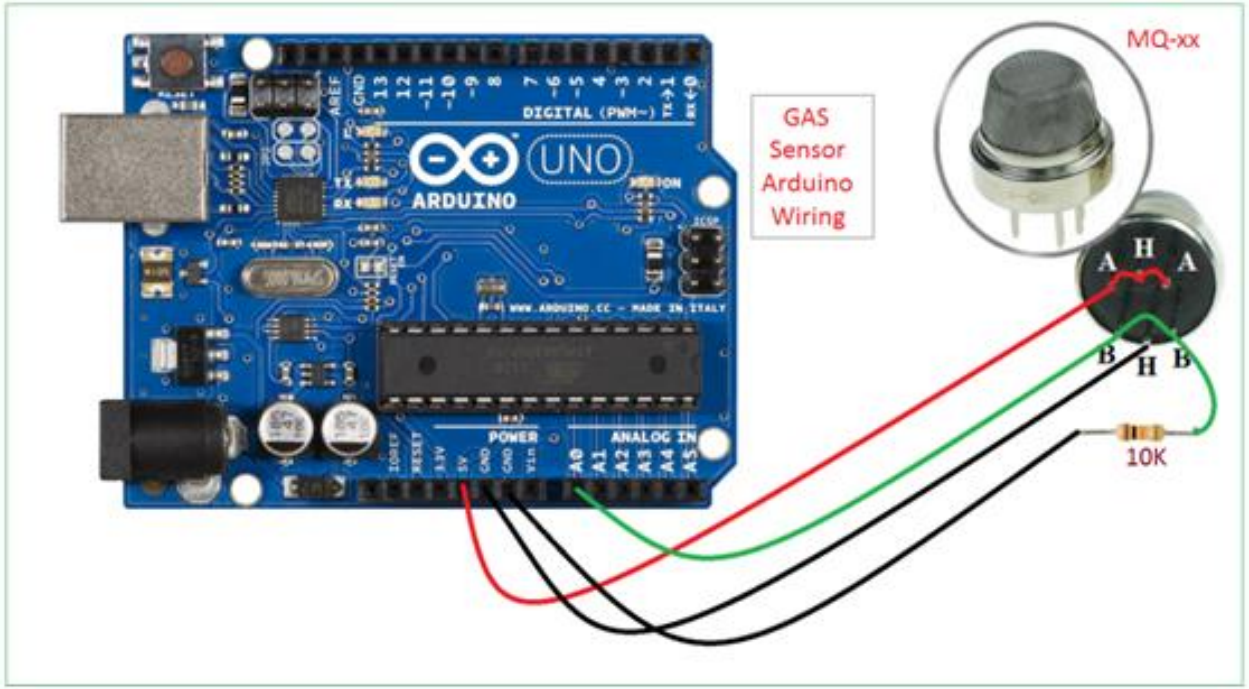
Their operating principle is based on the change of conductivity of a sensitive material when it absorbs or reacts with the gases in the environment

Block diagram of a smelling process with an MOX gas sensor

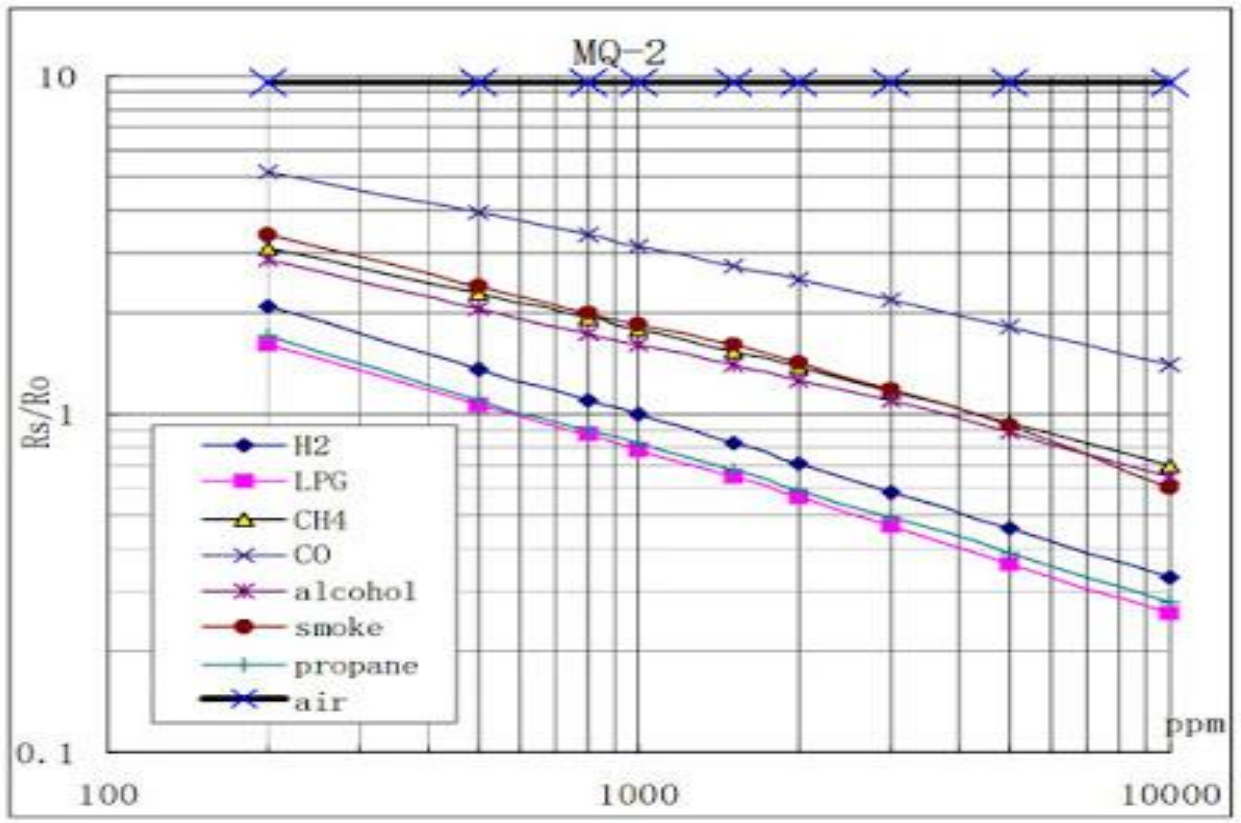


The sensor is excited by a volatile [ppm] producing a variation in the sensor resistance that is measured as an electrical signal [V] by means of a measurement circuit.

MQ-xx LPG & Natural Gas Detector Sensor Module for Arduino

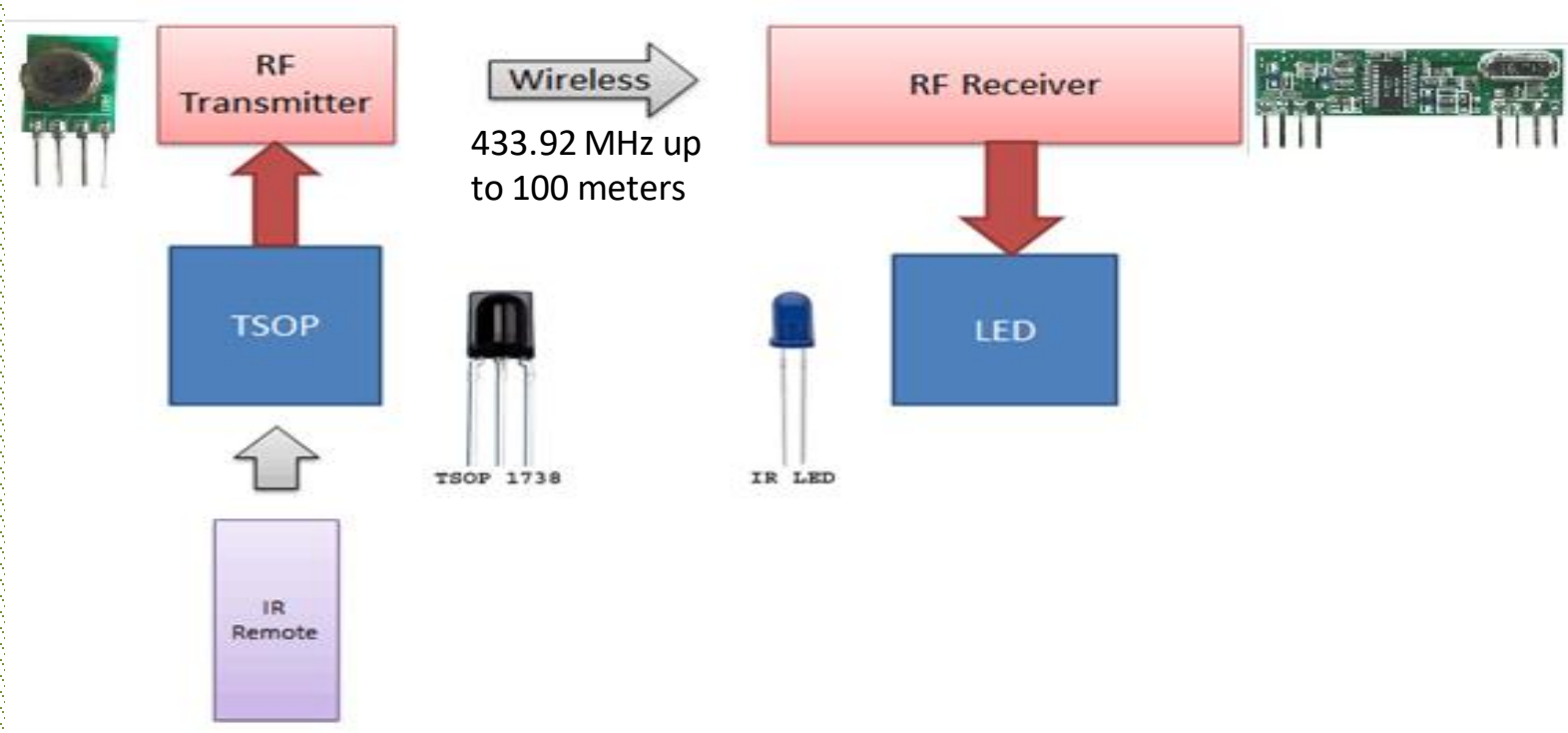


MQ2 Gas sensor sensitivity graph



Converting the IR signal into RF signal

- RF signal does not required line of sight and have much better and long range then IR remote
- TSOP1738 is working as a IR detector or receiver.



Code for Interfacing of MQ Gas Sensor with Arduino

```
int sensorValue;
int digitalValue;
void setup()
{
  Serial.begin(9600);      // sets the serial port to 9600
  pinMode( 0, INPUT);
}
void loop()

{
  sensorValue = analogRead(0);       // read analog input pin 0
  digitalValue = digitalRead(0);
  Serial.println(sensorValue, DEC);  // prints the value read
  Serial.println(digitalValue, DEC);
  delay(2000);                       // wait 100ms for next reading
}
```

CONCLUSIONS

- Structural and machinery failures in the day-to-day ship operations may lead to major accidents, endangering crew onboard, posing a threat to the environment, damaging the ship itself and having a great impact in terms of business losses
- Maintenance is a primary service to be performed in complex systems, especially those whose failures can compromise personnel and environmental safety, such as large ships on sailing
- It is open source software using robotic, embedded systems and IoT technologies
- It offers protection of human resources in applications that are hazardous to human work

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Department of Shipping
Trade and Transport

Εργαστήριο Πληροφορικής
και Νέων Τεχνολογιών στη Ναυτιλία,
τις μεταφορές και τη Νησιωτική Ανάπτυξη

Thank you for your attention

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