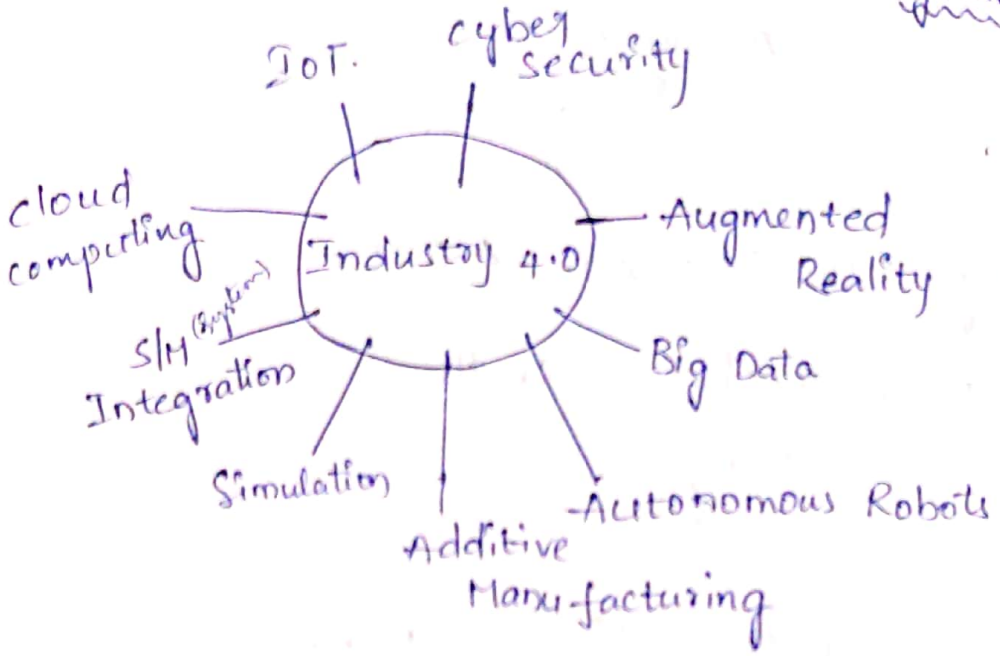
11/06/22 Unit-1

Introduction to Industry 4.0 & Cyber physical Systems



→ Industry 4.0 is a digital transformation of manufacturing production and related industries and value creation process.

→ It is an intelligent networking of machines and processes for industry with the help of communication technology.

→ Industry 4.0 was ~~developed~~ adopted by a german manufacturing company to be more competitive.

Evolution of Industry 4.0:-

1st - Mechanical systems → Steam engines, Textile industry, Mining and metalogy, Machine tools

2nd Technological electrification → Engines, Turbines, Adoption of telegraphs, gas and water suppliers

3rd Intelligent Digital manufacturing → Robotics, Digital networks and machines, ~~IoT~~ ~~Autonomous~~ machine, Advanced Robotics, ~~AI~~ IoT.

4th. IoT Autonomous Machine
Advanced Robotics
AI / ML
Big Data Analytics
cyber physical Systems.

Challenges in Industry 4.0 :-

* A gap in technical skills.
* Data Sensitivity

Ip privacy ownership and Management
Ex:- For an AI algorithm, data is required to train and test. Data is a powerful set to Kept Secure.

* Inter operability.
* Security
* Handling data growth.
  - companies depend on AI
  - More data is generated in multiple formats
  - AI algorithms are the easier to comprehent Vast amount of data.

→ Oppurtunities / Advantages of Industry 4.0 :-

1. Optimization and automation
2. Real time data for supply chains is collected properly resulting in good economy
3. Advance maintainence and monitoring.
4. Real time monitoring and IoT enabled quality

5. Superior Sustainability
6. Earning trust and loyality from customer.

Industrial Internet of Things (IOT):-

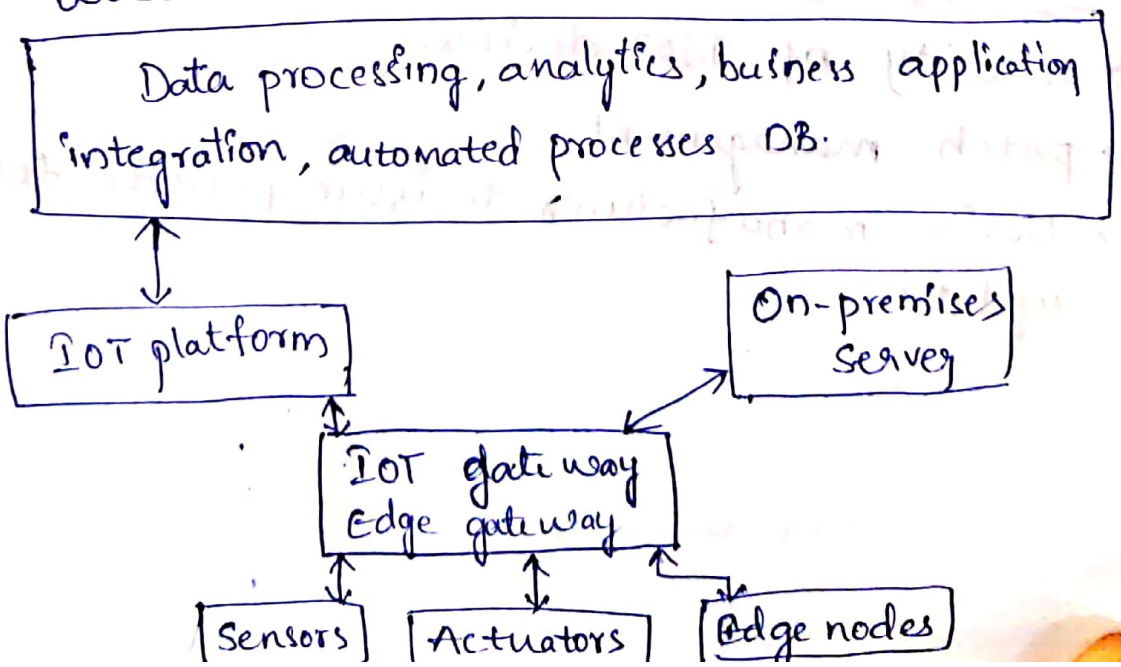
IIOT is use of connected technology to enhance manufacturing and industrial processes.

IIOT uses software sensors, data systems to improve speed efficiency and business performance.

Examples of IIOT are:-

* preventive maintenance.
* IOT Records and communicate run ~~times~~ times
* predictive maintenance.
* Energy consumption monitoring
* Batch Optimization
* Inline quality sensor:-
* ~~Deliv~~
  Delivers real time data and assists in real time data.
* Inventory planning

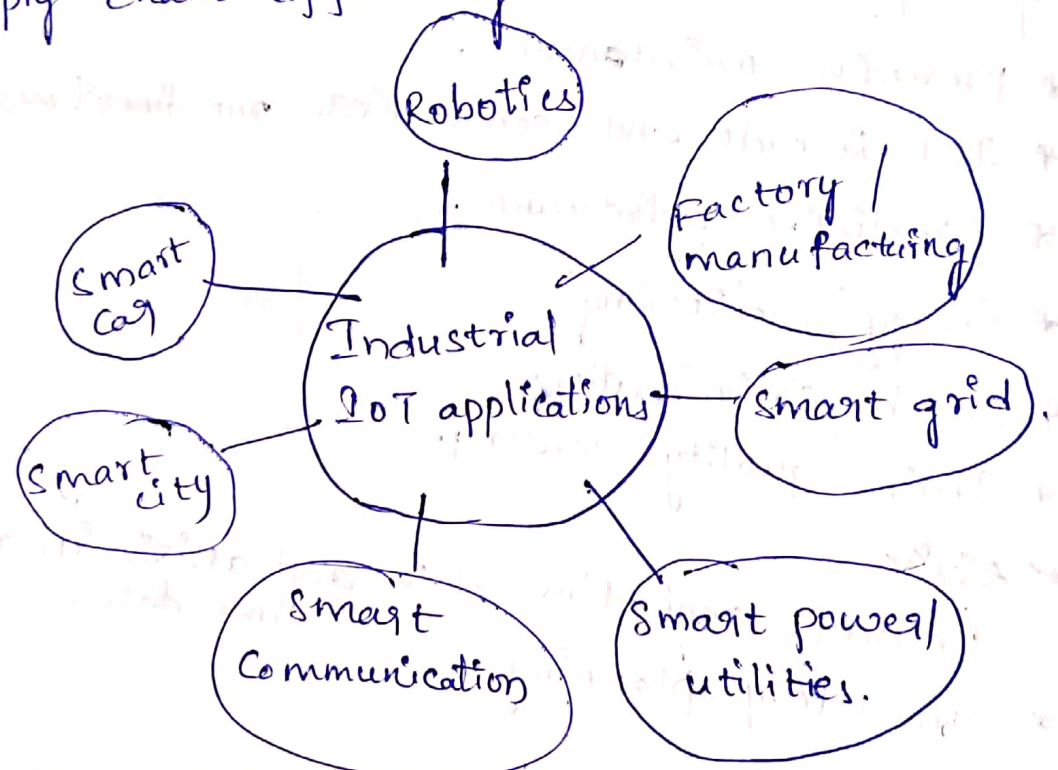
IIOT Infrastructure:-



Driving Idea for IIoT:-

IIoT has smart machines better than human at capturing and analyzing data in real time and also better in communication to drive business decision

Eg:- In manufacturing industry some of the practices implementing using IIoT are quality control, sustainable and green practices, supply chain management and supply chain efficiency.

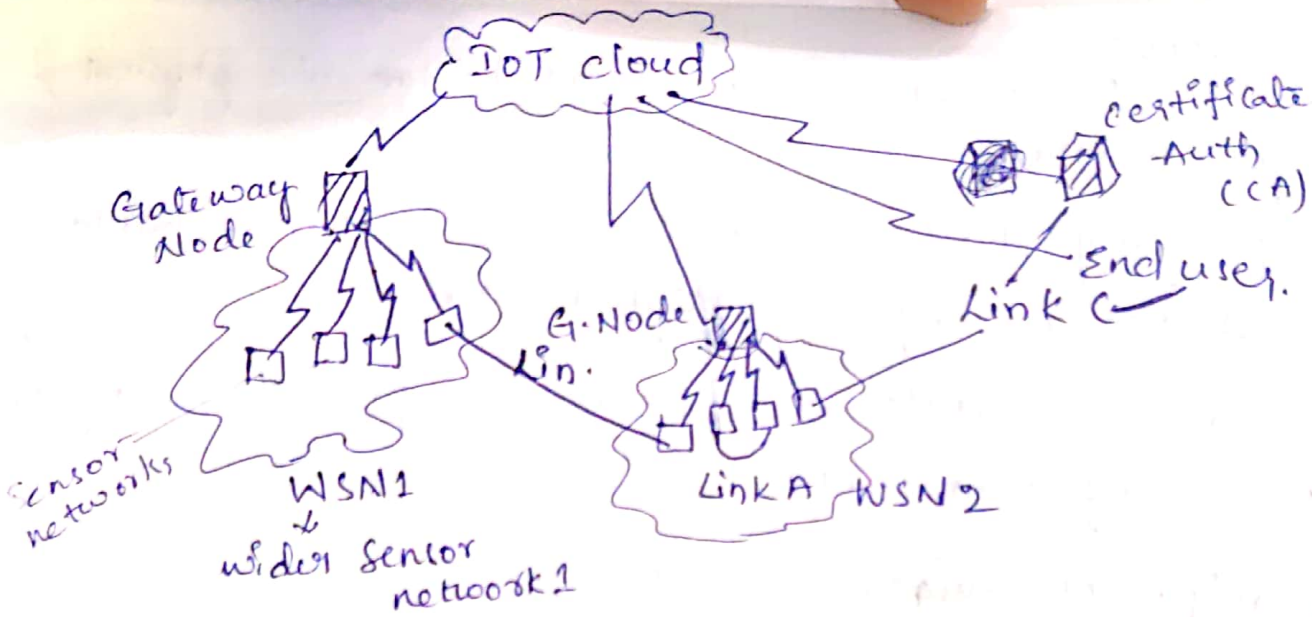


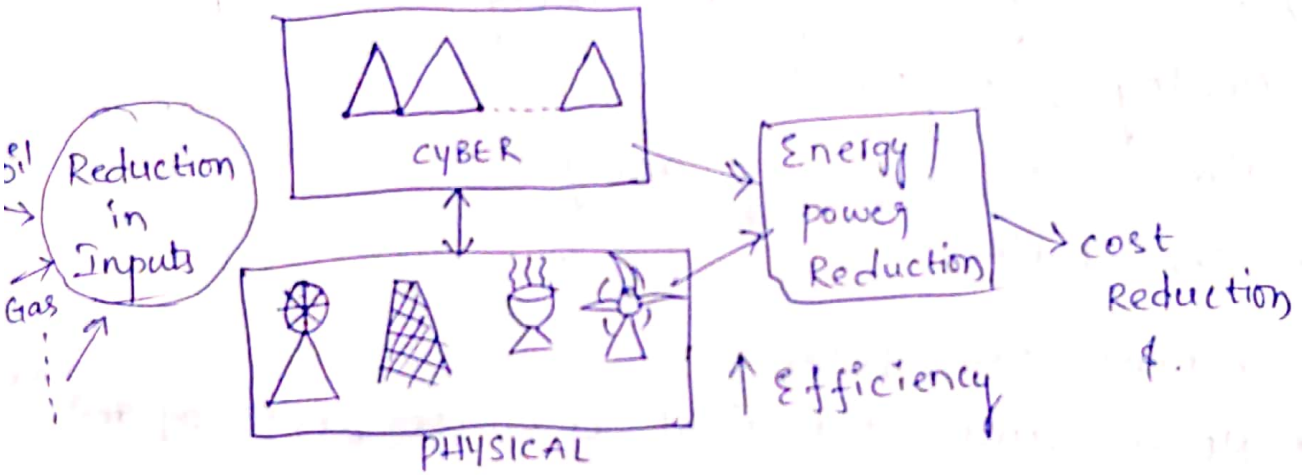
Challenges / Risks of IIoT:-

→ security of IIoT devices.

→ patch management

→ Device manufacturers to issue periodic format updates.





Basic principles of cyber physical Systems :-

→ cps is the bridging of engineering & physical world applications with computer hardware and cyber world.

→ physical world Examples includes :-

- elements of physics
- modelling
- Real world entity such as uncertainity & disk
- Embedded systems
- Networking
- programming with algorithms (AI)
-

Sensors :-

A sensor is a hardware bridge blw physical & cyber world

→ primary devices collect data from physical world, and use as 'input' in cyber world.

→ Once raw data is collected, it process via signal processing techniques.

principles of signal processing.

* Lineag signal & Systems theory
* Analog & Digital filtering
* Time and frequency analysis.
* Convolution
* Linear transform.
* Noise and statistical characterization of
Combining M.L, decision of Sensors

Control theory :-

Control theory elements stability and optimization

Stochastic :- In cyber

In cyber

principles;

* communication and networking
* Network protocols:
  → Layered architecture and real world applications of wireless communication need to be formulated.
* Real time management:
  → Real time scheduling
  → Temporal sematic in program
  → Clock synchronization in network.
* Distributed System
  cps combine h/w & s/w running algorithms across different devices in different location.
* Embedded Systems.
  → The design of high quality cyber components are needed.
  * It includes the
    - embedded software
    - Concepts of programming & algorithms
    - s/w design & h/w platform for manufacturing

* properties Related to environment and hardware platforms are considered

*Software Design principles includes safety, reliability real time performance, risk management and security

*Human Interaction :-
  human-in-loop control includes

understanding and accounting for human responses.

→ The main design issue is making cps available human to operate control and maintain any application.

Cps in Real world:-

→ Home Automation Ex = Cleaning Robots, Smart lightening, smart heating & Air conditioner system(
→ Smart Transportation, Vehicles Ex = smart car, plane, motorized scooters, electric bicycles, lane departure warning systems, Segway.
→ Medical field
→ Hydropronics
→ Industry

Ex: for (Medical field)

Insulinpumps
personal assistance robots
Smart prosthetics.
Variable fitness & health monitoring systems.

Ex for Energy:- Smart windmills & grids.
Energy harvesting technology.

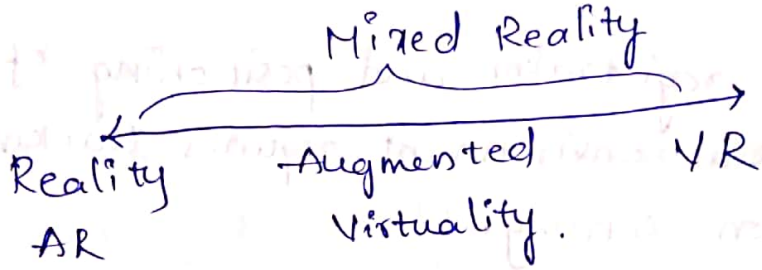
Agriculture :- Smart Agriculture monitoring.
Hydroponics gardening provides local supply of nutrition.

Augmented Reality (AR) in cps :-

AR Systems that suppliment real world with virtual objects that appear in same space as real world.

→ AR related to virtual reality (VR) based on real world with virtual elements inserted in mixed reality, Mixed reality includes virtual and real elements together.

→ VR is the current innovation towards visualization



AR spectrum

AR adds digital element projecting the virtual pictures & characters through phones

VR is the computer generated simulation that is visible of.

Computer Sensors headsets and gloves.

Key enabling technology in AR components are :-

Media Representation

AR

Vary text symbol & indicator, 2D image, 3D

wire frame, Data and module with animation representi...

Input Mechanism

Virtual information is presented to add real world information content

Output Mechanism:-

Devices used to support content presentation and system responses to the user

AR focuses on visuals and graphic objects and overlays.

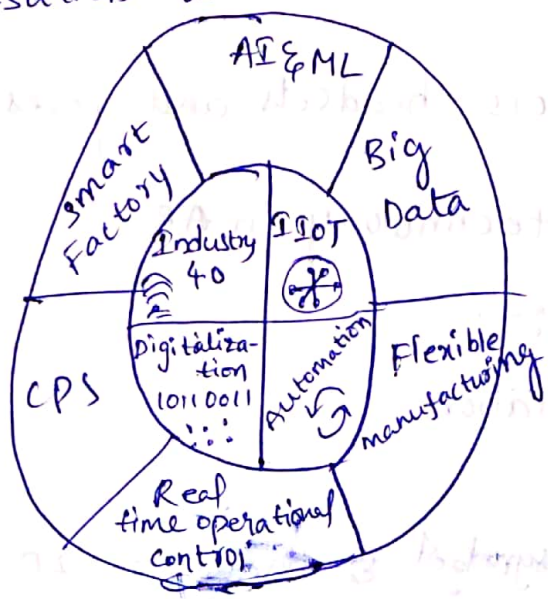
Trackers:- Accurate registration and positioning of Virtual objects in real environment requires tracking accuracy and location sensing.

→ The major challenge of an effective AR system requires an accurate long range sensors and trackers.

AI in ~~CPS~~ CPS:-

→ AI is a key technology large scale cognition CPS. represents learning of complex behaviour and interaction b/w system components and data use.

→ Distributed AI used in self managing, cooperation and virtualisation abilities for large scale cognitive cps



AI approaches

The main idea behind AI is to enable machine to think & work, computing machinery and intelligence was given by Turing in 1950 with a turing test, which was the fundamental goal of AI.

→ The limitation of AI is to build machine that are more intelligent and dynamic.

→ AI is the study of agents that receive percepts from environment and perform actions.

4 different approaches in AI:-

1. Thinking humanly } related to Thought process & reasoning
2. Thinking Rationally }
3. Acting humanly } related to Behavior.
4. Acting Rationally }

Types of AI :-

1. Reactive machines :-
   - → These machines cannot store memory.
   - → " " are assigned only a limited no. of specialized duties.
   - → More trustworthy and reliable

2. Limited Memory :-
   - → Ability to store previous data & predictions for making potential decisions.
   - → To provide usage of limited memory in AI, following steps are followed:-
     - Training data must be created
     - Design a machine learning model
     - Model must be able to make predictions
     - Model must receive human/ environmental

Three major machine learning models are:-

1. Reinforcement Learning:-

→ Repeated trial and error for use, weather prediction.

2. Long Short Term Memory (LSTM)

→ LSTM uses pass data to predict next item in sequence

3. Evolutionary Generative Adversial Networks (E-GAN)

→ This model explores modify paths based on previous experiences with new decisions evolving over time.

3. Theory of Mine:-

AI machines grasp psychological concepts on real time and make decicions by self-determination and reflection.

4. Self awareness:-

AI machines possess human level consciousness and understand its efficient in real world with the appropriate remotness state

→ Self awareness relies on two challenges aspects :-

1. understanding the level of consciousness
2. Learning how to replicate.

Big Data in Cyber physical Systems:-

Big Data with AI & ML is feeling the forth/4th Industrial revolution.

Big Data Analytics is replacing business process and operations

IoT Networks depends on

- Data as product
- Quantum computing
- Data for hyper-personalization.

Applications of Big Data :-

* use in Health camps
* E-commerce
* Banking and FinTech.
* Security
* Manufacturing
* Natural Resource management.

In Banking sector Big data is used for processing of fraud detection, proper fund balancing, settlement and customer Segmentation.

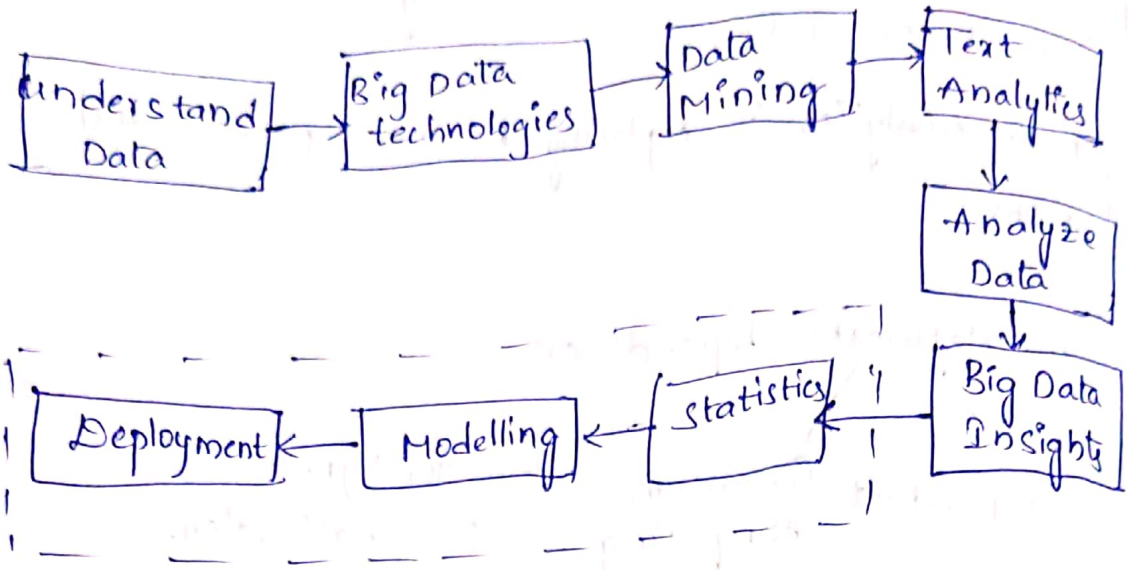
Predictive Analytics :- It uses historical events & model data to uncover hidden trends/patterns.

Ex:- no. of customers living brand in a couple of years.

no. of products to sell in the upcoming quarter.

→ Data driven user prediction are made using predictive analysis such as customer response, purchase behaviour, services, business agendas.

Big Data Analytics processing:-



*Big Data Analytics is capable of making decisions five times faster than Big Data Storage.

IOT Smart Analytics:-

Digital interconnection of everyday objects with internet. The purpose is to make human lives easier to take proper decisions and execute actions.

Smart Machines will completely revolutionize and digitilize industries & markets

The main challenge in IOT Smart Analytics is
→ The ability to collect & analyze the entire stream of information sensed from the environment.

* Sensors also called as transducer, is a physical device that converts one form of energy into another i.e. any physical phenomenon into.

Actuators:- Operates taking electric input and turns into physical actions.

Ex:- Hydraulic system, electric motor, pneumatic System.

Controllers:- Sensors inputs is collected and routed to a control center.

controller consists of defined logic used in taking decisions

Industrial processes:-

It includes procedure containing chemical, physical, electrical & mechanical steps to help in manufacturing of an item or items, usually carried out on a very large.

Challenges in Industrial process control:- (IP)

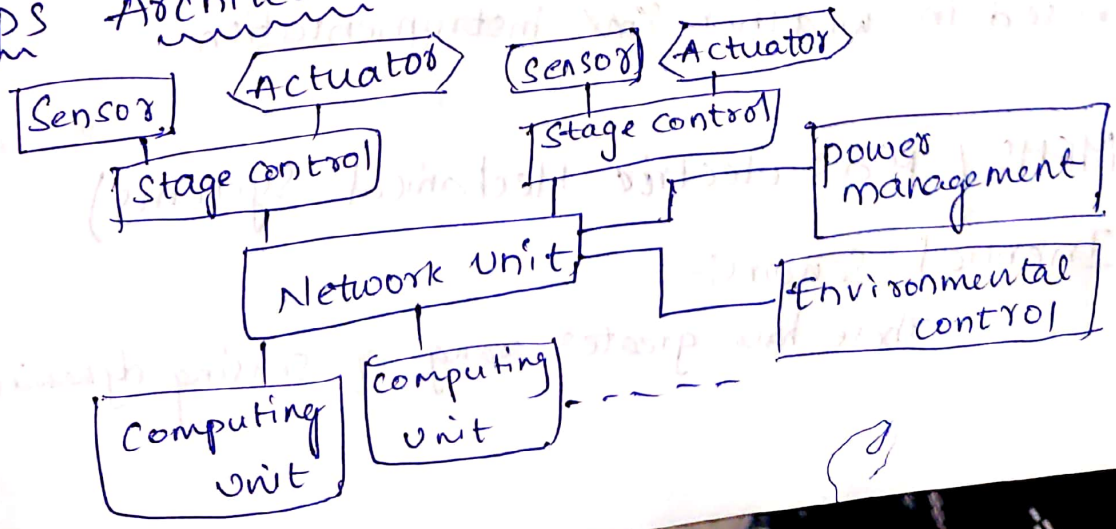
1. Heterogenity checks using current control communication and software

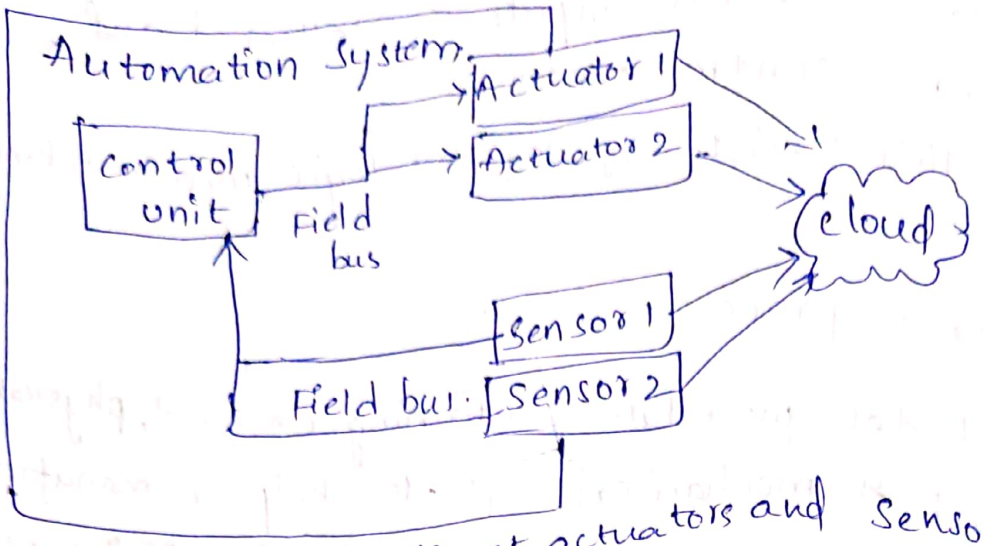
2. Coverage & connectivity:- It includes proper sensing, processing, communication and activation in control loops.

3. Handling Network Routing, Verifying & Retransmitting message in large scale networks.

4. Improve communication and control theory for real time and reliable connectivity

CPS Architecture:-





usage of intelligent actuators and sensors.

Types of Sensors:-

* Digital Temperature Sensor and Humidity Sensor
  - These are weather proofs for continous measurement as soil and water
  - stable and accurate
  - ~~fre~~

pressure Sensor
  - Takes pressure readings as input, convert electric
  - used in industrial & hydraullic machine
  - ~~Vaccum~~

Vaccum Sensors:-
  - These measure pressure below atmospheric pres
  - used in weather ~~ins~~ instrumentation.

MEMS (Micro electric Mechanical Systems)

Inertial Sensors:-

these have greater range of sensing dynamics

Motion sensors

Torque sensors

measures twisting or turning of forces.

Rotating Torque sensors.

Short Transducers :-

These are a part of dynamo-meters providing measurement of & angular speed to calculate output power.

Cps in manufacturing Industries :-

Five level architecture is followed in manufacturing Industries.

1. connection
   - Refers to data generation
2. Conversion
   - uses algorithm to convert data to information.
3. Cyber
   - identify large data patterns.
4. cognition
   - Monitors & detects its own failures.
5. Configuration
   - The machine tracks & detects early failures and sends information.

Next Generation Sensors:-

* Handheld Molecular contaminant Screener (HMCS)

Collaborative platform

It is a Virtual space where resources a tools are centralized supporting communicati and personal interaction in corporate projects

→ It involves: 1. project update
• Monitoring & management.

2. Document Sharing
• Exchanging information about progress initiative

The main aim of Collaborative platform is to enable s to work together by simplyfing proj monitoring task and their by delivering efficie

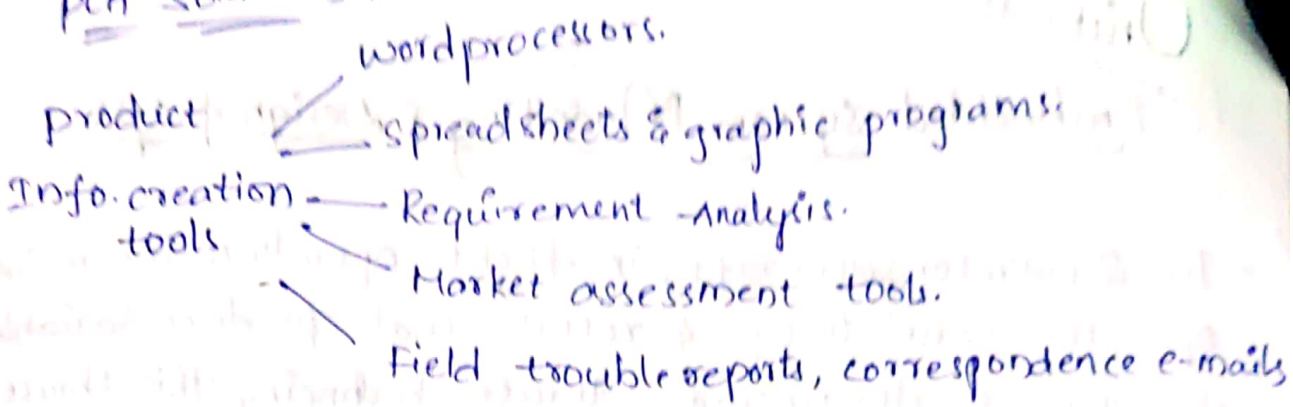
→ It has to initiate product increase and financial savings in the organisation.

→ It's main object is

1. project portfolio management
2. Continous ~~equipment~~ improvement.
3. Development of innovation.

Product Life cycle Management (PLM)

PLM Solutions :-



PLM is a encomposing machine for managing data related to design, production, support and disposal of manufacture rules.

*Main target of PLM is a safety & control mainly in aerospace, medical device, military and nuclear industry.

PLM Solutions :-

→ Repostery of information related to product management.

* A PLM tool focuses on managing data covering the product life cycle without how data is developed.

Elements of PLM:-

1. Managing designs and process documents
2. Concerts and contools bills of material records.
3. Offers e-file reports
4. Maintain built in custom path and document at the data
5. permits item focus/base task assignments
6. Enable work-flow, for approving changes.

7. control multiuser access security
8. coordinate with erp strip.

Unit-II

Embedded System Modelling & Design & CPS

1 → In Quadrotor aircraft, in flight operation the ma
operator consists of 4 rotors that produce varia
amount of downward thrust balancing this thru
from 4 rotor can take off, land, turn and
snip in air.

Challenges:-

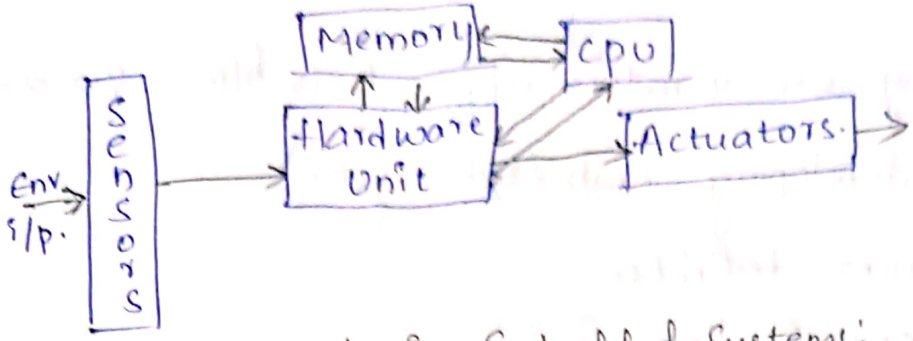
- Autonomous operation is required for Quad rotor.
- Landing
- Modelling of dynamics in environment and embedded systems.
- Design process.

Three major parts

→ Modelling - Gaining deeper understand System.
→ Design - It describes how the system is presen
→ Analysis. Deeper decisions taken based on data processor.

* Embedded system is a combination of computer hardware & software designed for specific functions.
* This system is programmable or have fixed functionality

Embedded System:



platform components in Embedded Systems:

- There are three types of components

1. Hardware
2. Applications specific software
3. Real time operating systems.

other components in this includes - power supply given to embedded circuits

- processor for storage.
- Timers and counters
- communication pores
- Input and output devices.
- loop circuits used in applications.

Embedded System specification:-

In embedded Systems the structure oriented model describes the systems physical module & interconnection b/w them.

There is either coprocessor implementation with a memory or processor implementaion with cross-bar

Major areas of design process:-

1. Ensure good h/w & s/w specification.
2. Formulating architecture for systems in aphysical

3. Partitioning of h/w & s/w design
4. Area of
5. Developing an iterative approach to h/w & s/w design

Steps in developing embedded system:-

1. Requirement definition.
2. System specification
3. Functional design.
4. Architectural design
5. prototyping

System design specification (SDS):-

→ SDS is a complete document containing all informative to develop an embedded system.

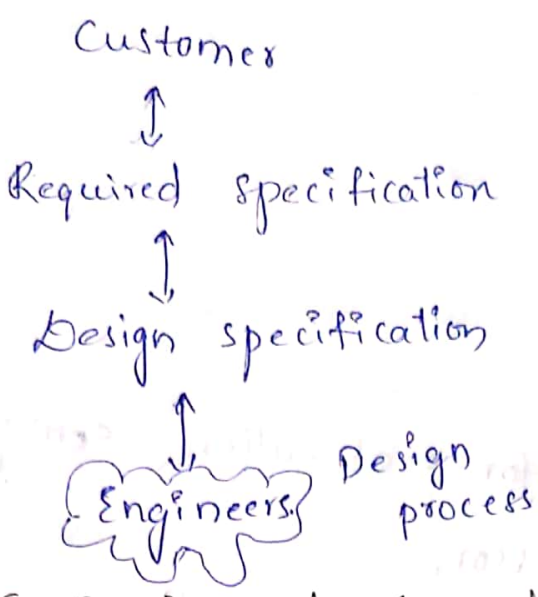
→ System design is a process of defining architecture components, modules, interfaces and data for the developed embedded systems

→ It bridges the customer & embedded system design.

→ Two important design requirement for specify systems public interface, for specify how requirement are define and how the initial functions of systems.

** Five areas must be considered for design.

1. Geometrical construction.
2. Characterization of constraints on interface signals
3. Temporal constraints
4. Electrical infrastructure.
5. Safety & Reliability



Concepts & Requirements of embedded systems.

Requirements of E.S :-

* The adopted s/w used in embedded system.
  Embedded C, C++, python, Java, Verilo etc.
* The OS that can be used are linux, OSE, nucleus ORDS, windows c, thread 'ex'.
* Temperature & Environment factors of the system, objects with e.s are integrated with iot and machine to machine devices.

Real Time Examples for E.S :-

It includes - central heating System.
- GPS
- Fitness tracker
- Medical devices
- Automotive systems
- Transit & fare collections.
- ATMs
- Factory Robots.
- Electrical vehicle charging
- Interactive kiosks

Abstraction levels :-

- Interpretation
- Translation
- Extension

Inter pretation :-

-A Technique for realization semantics of a language.

-Micro coded processor.
-It maintains a level of abstraction.
-Instructors are visible to programmers & those are instructed by low level

Translation :- It is a linear form of abstractive Implementation.

- Behavioural synthesis & logic synthesis are integrated

Extension :- It defines the h/w design as translation & interpretation.

→ Object Oriented language provides a
→ certain level of abstraction as followed level of
a' in c++ → other upgrades in s/w upgrade & h/w design
specification must be fulfilled in extension abstraction level.

Test Benches

Different types of Benches.

1. Testing Single architecture component
2. Testing multiple arch
3. Simulated Timing
4. Timing checks.
5. Modelling & Testing Synchronous Systems.

Design under Test :-

* Embedded Testing is the process for checking functional & non-functional attributes of both s/w & h/w in embedded systems ensuring that final product is defect free.

* Main purpose of embedded testing is to verify and validate final product of h/w & s/w fulfilling the requirements of

* Test and ensure whether concern software is good quality and requirements.

-

How to perform Embedded Testing.

→ Software is provided with some inputs
→ Software execution
→ Software state is observed and outputs are checked for expected properties.

Challenges in Embedded Systems Testing

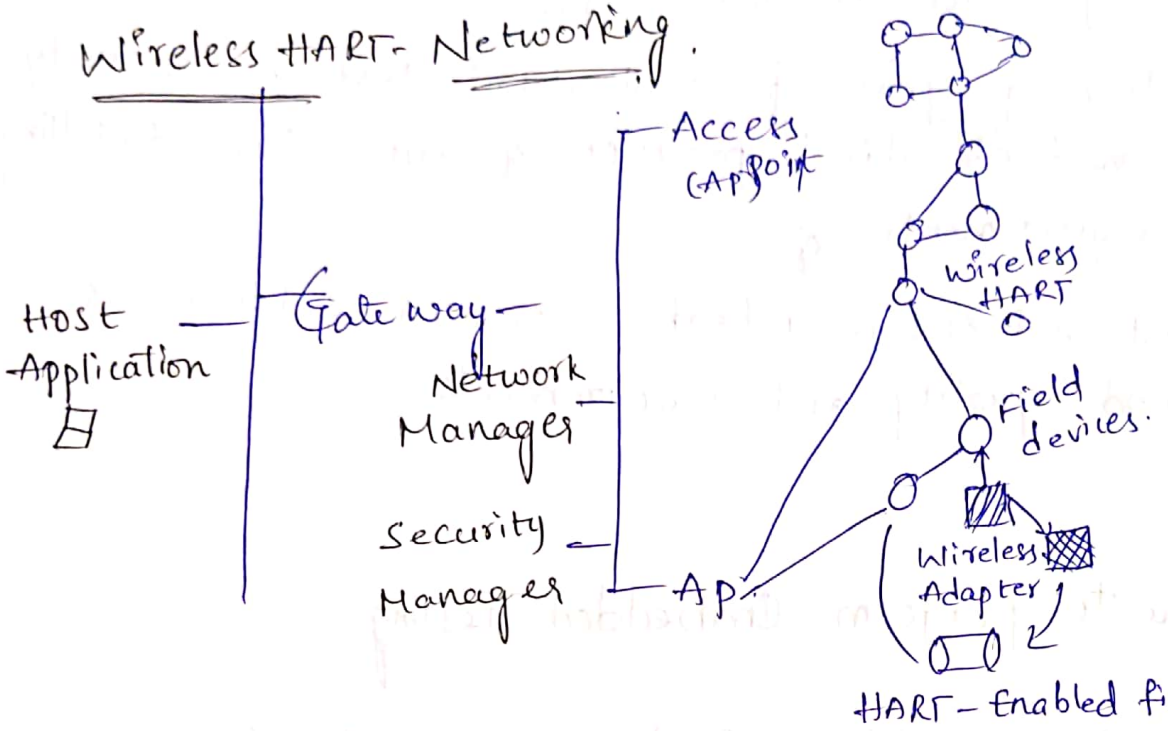
1. Hardware Dependency.
2. Opensource software design.
3. Software and hardware defects
4. Reproducible defects.
5. Continous software updates.

Wireless HART :-

→ HART - Highway Addressable Remote Transducer protocol
→ protocol :- 2.4 GHz ISM band, IEEE 802.15.4

→ Based on Dust Network's TSMP tech
↓
Time Synchronized Mesh protocol

Wireless HART- Networking.



→ Wireless HART within Telecommunactions & computing is a wireless sensor networking technology.

→ Users in cps see a simple, reliable & cost effectiv for better to deliver values for control system without using more wires.

* HART is a Request-Reply protocol referring to small field device only speaking when spoken by hart
* Designed for process automation, maintaing low business & security

*

- Wireless Hart initializes time synchronize, self-healing, mesh architecture
- WiHART is based on dust network standardization
  TSMP - Time Synchronize Mesh protocol.
- HART is widely used for field communication for intelligent process implementation

Working of WiHART :-

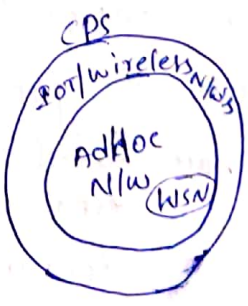
There are 3 main elements in WiHART:

1. Wireless field devices connected through to process or plant equipment
2. Gateway :- It is a communication b/w device & host application connected to high speed background network all other existing plan.
3. Network Manager :- It is used for configuring for a CPS, in
   - Scheduling communication b/w devices, managing message route and finally monitoring network

- Wihart uses industrial scientific & radio, isc bank
- Wireless Hart standard support multiple specific.

1. One way process publishing and control
2. Measuring of values.
3. Notification by exception
4. ~~Add of~~ Adhoc request or response and ortho Segmented block of large data set.

log transfer



Components of WirHART :-

1. Gateway - provides connection to port networks
2. Network Manager - builds & maintains mesh network.
   This manager identifies dust part & manages slot time access.
3. Security Manager - Manages & distribute encryption key & holds list of organization.
4. Measuring devices - are used for process management.
   - Repeated, adapted & hand-hind terminals.

Intellectual property Components :-

* Embedded Systems needs to protect a intellectual property (IP) for financial, competitive & legal reasons.
* protecting of IP, securing library or right manage contains from vender must be maintained on failure of IP in embedded systems leads to risks - financial risks.
* Techniques prevents risks.
  - Software based IP protection
  - Anti-disassembly.
  - Anti-debug
  - Tamper resistance.

Intellectual property components

- Software based
  1. Anti-disassembly :- This technique is more challenging for an adversaries for an understanding to

Sample ~~Resistance~~:
provide static view of s/w IT in executable form.

2. Anti-debug:- Technique to prevent successful s/w debug.

Debug detection includes Monitoring changes in memory resistors, self challenge for break points, & measuring delay b/w points in code

3. Tamper Resistance:- Mechanism used s/w program to prevent adversaries to modify program.

Ex:- s/w coding.

- Hard ware based:

Methods used in Embedded processor to protecting

Methods can be also employed across system level, board level and ---

System Level :- Mutual watch-dogs keep a small microcontroller or processor provides time and services.

Board Level:- It includes techniques for h/w access points into processor & data lines of memory devices.

Board layout techniques.

Controller Area Network (CAN):- CAN is the way of communication protocol used for embedded devices under specification

→ CAN data frames has fields such as Arbitration, control data check & ack field,

→ Used in Automobile industry, before CAN electronic devices wired connection

→ CAN bus systems allows electronic control unit to communicate each other without complexity. each ECU is connected to common serial bus.

Node in CAN bus.

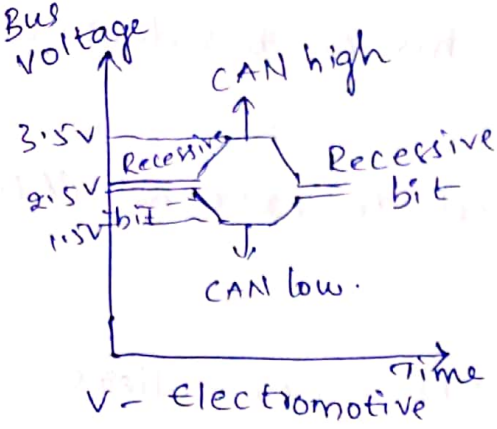
* Host Microcontroller unit
* CAN controller - It is a chip embedded / added seperately
* CAN Transceiver
  - Transmitter + Receiver.

CAN bus Electrical Specification:— It is single ended signal & differential signal are produced by Can known to be a CAN H (High) & CAN L (Low).

→ In ideal conditions both the high & low are at 2.5V

→ Logic 0 is called dominant bit.

→ Logic 1 is called recessive bit



V - Electromotive force.

→ Recessive bit is transmitted in CAN high & CAN low

→ CAN bus terminators resistance of 120 Ω must be added as physical end of CANH & CANL

→ To avoid signal reflections

CAN layer Architecture.

1. physical layer :- physical coding is implemented in CAN Controller chips
   → Represents tranceiver characteristics.
   → physical media Suppliers

2. Data link layer :- It connects actual data to protocol for sending, receiving & transmit the data.

3. Application layer :- Interacts with OS or CAN bus

* CAN bus supports for micro controller.
* CAN bus shield for Arduino, Raspberry pi, STM32
* CAN bus controller along with SBI interface & CAN transceiver provides CAN bus capability to arduino board.
* Used for

→ Raspberry pi CAN bus :- This can bus does not have specific h/w.

* Raspberry pi connected to external CAN controller through SPI

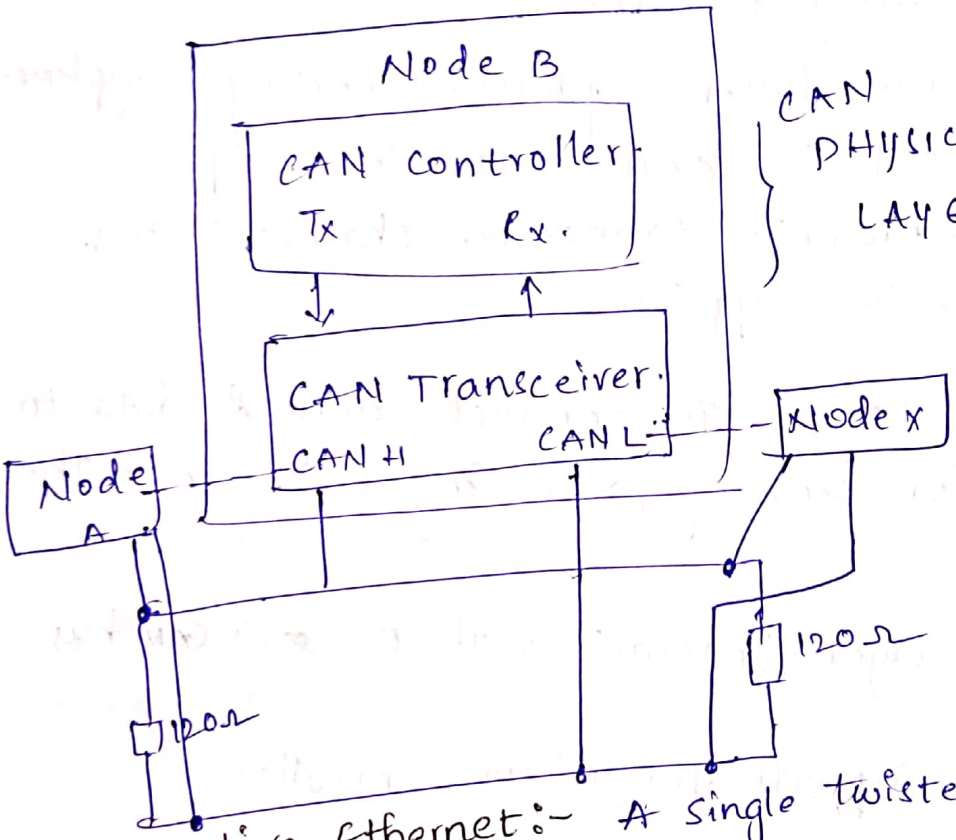
STA100, MCP2515 - controllers

TJA1040, MCP2551 - tranceivers.

→ STM32 CAN bus :-

STM provides CAN bus stands for GPIO.

CAN Bus Wiring Digram :-



Automative Ethernet :- A single twisted pair (STP) used for transmit an receive operations at same time

→ Automative ethernet is reliable & much faster networking protocol used in self-driving cars, vehicle to vehicle connectivity (V2V).

→ V2V connectivity advance driver assistance skill (adas) and In vehicle Infortainment (IVI) systems need for

Need for Auto

- For increase bandwidth & security flexibility for data transmission
- cost
- In-Car networks.

Benifits :-

1. Radar / Lidar (Light detection & Ranging)
2. Traffic sign Recognition.
3. Personal data maintainence.
4. Remote Start
5. Lane assistance.
6. pedestrian detection

* Ethernet provides 100mbps to highspeed.
* IEE802.3 is responsible for aeetomolive ethernet.
* Media Oriented Systems transport (MOST) is a network for infotaiment & media systems
* MOST offers 100 to 150 Mbps speed.

Automotive Ethernet Resources :-

→ Automative ethernet aims 98.5% efficiency 6.6kw design for EV (Electronic voltage) on board charger.

→ Isolated current sends different design for HEV/EV traction inverter.

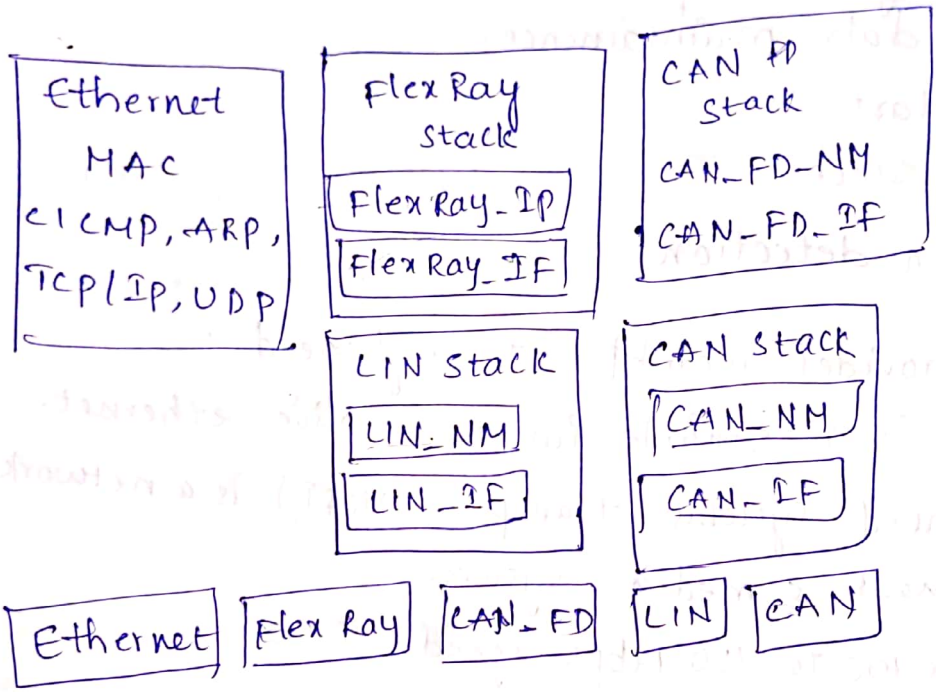
→ Leakage measurement & Reference design

→ Ethernet provides bandwidth & Scalability with light weight.

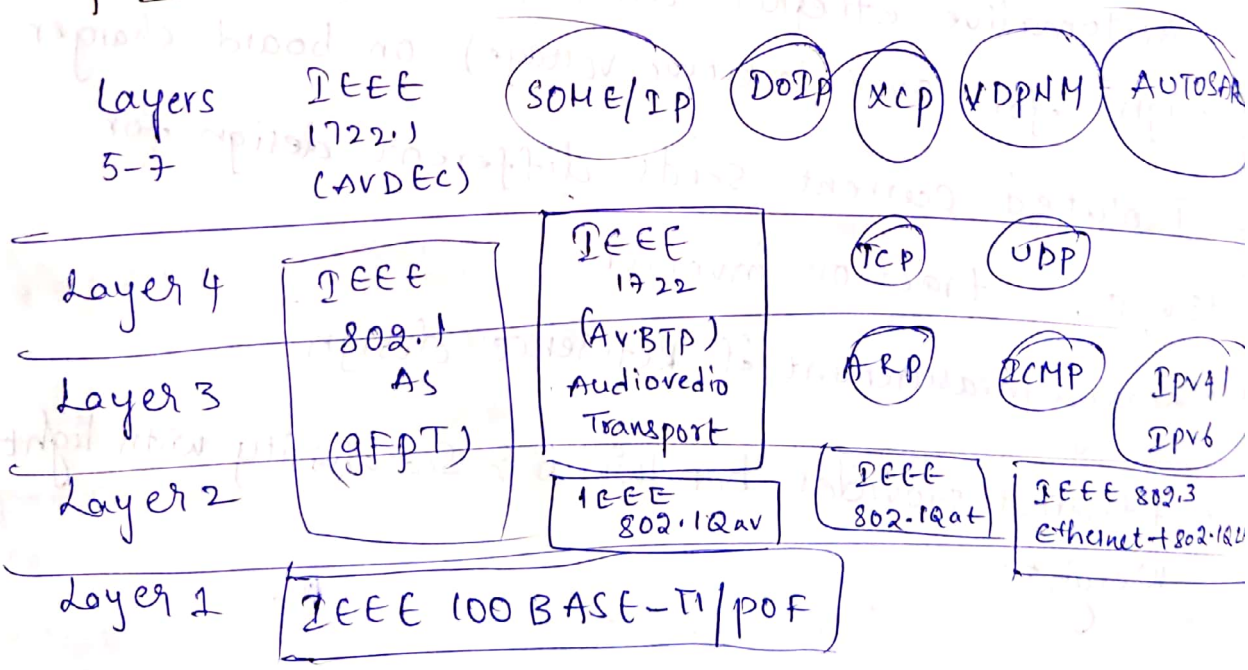
Challenges of AE:-

→ Connectivity of vehicles to smart infrastructure
→ Increase compatibility with the existing infrastructure
→ Improvement in network methods.
→ Security constraints.
→ Software stack of automotive ethernet.

Operational Stack



protocol Arch:-



E/E electric bar electronic architecture

* This increases the distributed s/w function & complexity in connectivity

* Functions performed in the stack include :-
  - reconfiguration during runtime
  - service-oriented communication
  - partial s/w update
  - simplified Software development using interfaces.
  - XML based interface descriptions

Flex Ray :-

composable UL channel ecu communication protocol

* Flex Ray supports higher bandwidth i.e., used applications like body control module & adas

* ISO 10681-1:2010

* CAN FD is an abbreviation to faster & flexible, ideal communication for

LIN STACK :- Lin stack is used in Roofing Systems, central login systems & wipers.

CAN 2.0 is a major communication protocol in

protocol Architecture :-

Application Layer protocol :-

SOME/Ip - This was proposed by BMW.

→ Serves oriented communication method for isolation & components and for modular design.

DOIP :- It stands for diagnosis over Ip

XCP - stands for universal measurement and calibration protocol.
It is used for small scale programming.

UDPNM - udp network management protocol.
It is based on data transmission and support automotive ethernet

AUTOSAR : Stands Automotive open system Architectur
It realizes sleep & wake up of automobile ethern no

Real Time operating Systems:-

Features :-
→ context switching latency should be minimized
→ Interrupt display should be short.
→ Interrupt dispatch latency must be short
→ Reliable and time bound inter process mechanism
→ Support kernel preemption.

Functions :-
→ RTOS is responsible for task management and sched interrupt servicing.
→ Inter process communication
→ Synchronization
→ Memory management

Types of tasks in RTOS:-
→ Hard Real time
→ Soft Real time
→ Real Real time
→ Firm Real time.

scheduling of tasks in RTOS :-

Issues in cps related with RTOS age :- spatial factor
scheduling cpu / network bandwidth

Real time schedulling algorithms :-

1. Rate monotonic - RM
2. EDF - Earliest deadline First
3. LST - laeast slack time First
4. ELST - Effective least slack time First
5. O-ELST - optimized ELST
6. H-ELST - Heuristic ELST

EDF :-
→ Task A & Task B conflicts, the task with least slack time is scheduled / computed first

ELST :-
→ preemptive, LST present in the ELST

O-ELST :-
→ changes in scheduled is assigned for tasks to improve real time performance.

→ H-ELST focuses on .

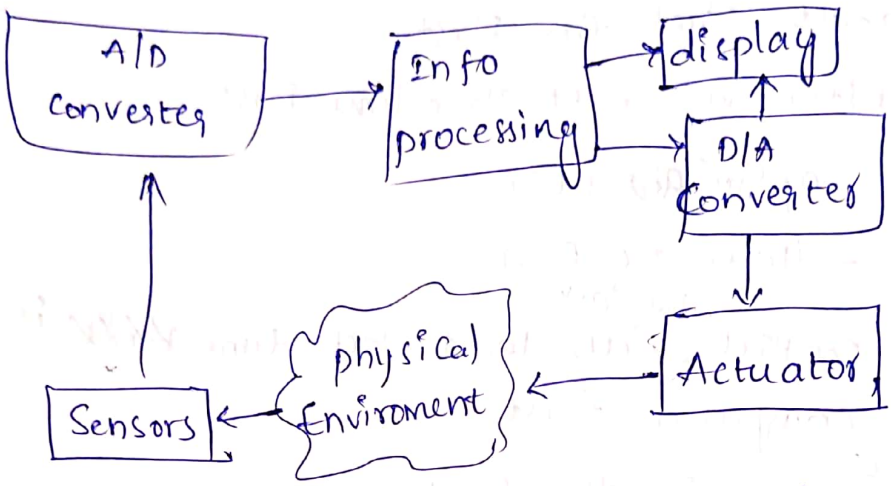
Discrete events simulation :-

cyber physical systems

There are 2 examples of h/w platform in cps frame work are called as COSSIM - Novel comprehensive ultra fast security aware cps simulator

COSSIM is a Nobel source framework designed by R

2. AXIOM - It stands for Agile extensible fast IO Module



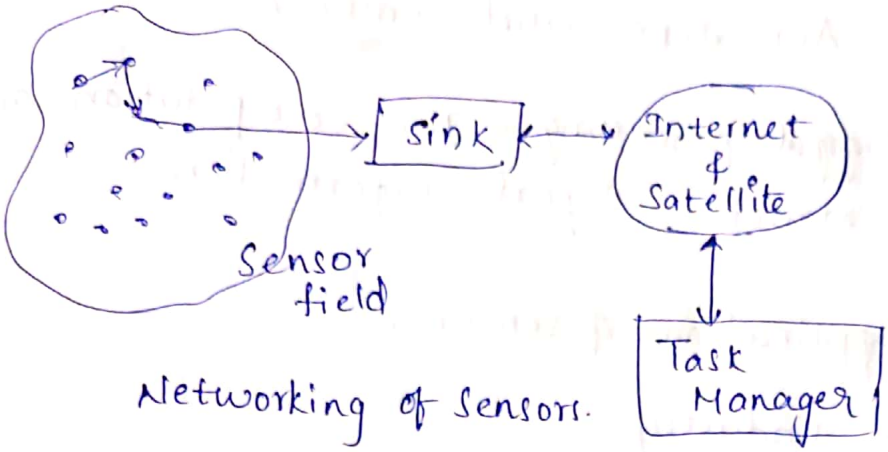
- cyber-physical s/m h/w platform

Decentralized system architecture in cps:-

Features of decentralized

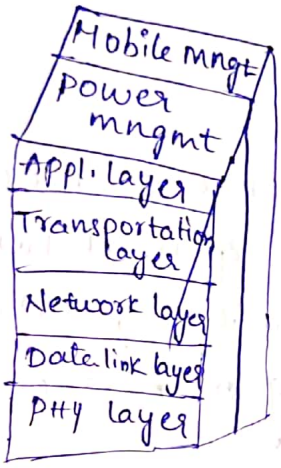
- Automatic production plan generation
- production plan validation
- Two stages under decentralized operations in cps are:- Aggrement & safety
  Feasability & authoricity of plan.

WSN Environment



Networking of Sensors.

protocol stack for WSN



Unit-III

Sensors, Actuators and Sensor Networks

Collaborative signal processing:- The cooperation access signals to extract signals information

Real time applications of sensors:-

1. Automotive Industry
2. Manufacturing Industry
3. Aviation
4. Medical & Heathcare.
5. Marine.

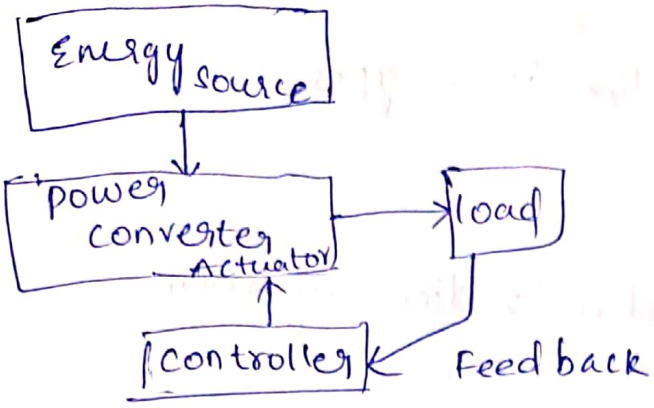
2. 1. Traditive maintainance of machinery
   2. Optimata utilization of machines
   3. Fight tuning & quality systems.
   4. Againty depending on market.

Actuators:- consists of:

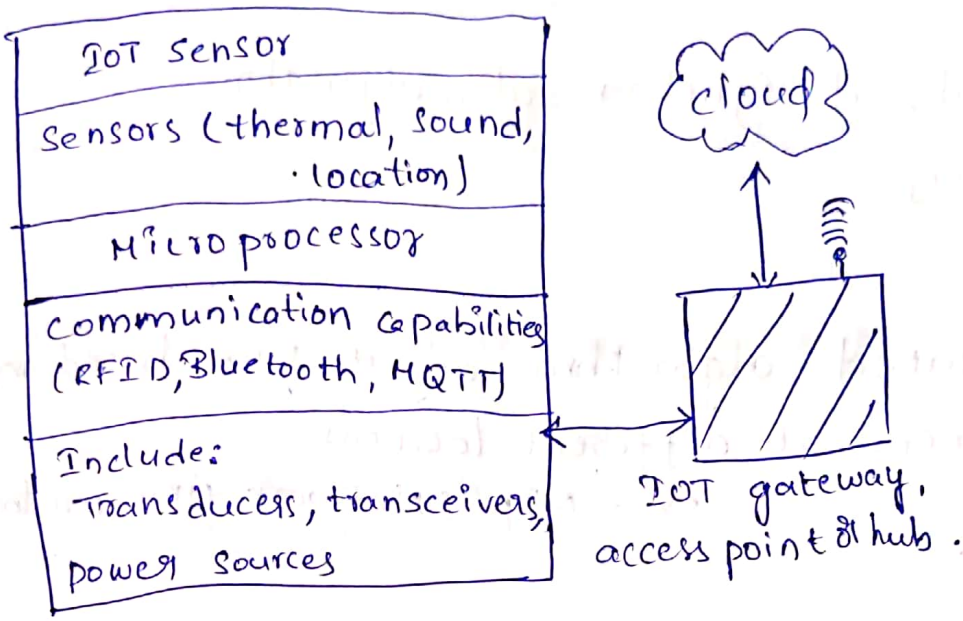
1. Energy source drawn from external sources (it can be electrical / mechanical).

Applications of Actuators:

1. Material Handling
2. Robotics
3. Food and bevarge manufacturing.
4. window automation
5. Agricultural machinery
6. Solar panel operations
7. cutting equipment
8. Valve operation



IoT Sensors in action:-



Applications of IoT smart Sensors

→ Temperature sensors are used to the overheating of maching
→ vibration sensors to detect loose vibrations in machines.
→ Security Systems
→ smart locks
→ motion sensors.
→ Windows & door sensors.

Time Dependent Systems:- clock Synchronization.

A collection of computer using high speed communication networks in a distributed network.

Needs for clocks:-

- For proper allocation of System resources to the preserve stay and for coordination of processes Synchronization is used.

clock synchronization is 2 types

1. Internal.
2. External.

Two types of synchronization algorithm.

1. centralized "
2. Distributed. "

Centralized synchronization algorithm :-

Berj

Distributed algorithm adjust time based on local differences at different locations.

Ex:- NTP (Network time protocol).

~~→Netwo~~

Task scheduling :- It is the process of deciding which task will utilize cpu time

priority ~~Assignment~~ mechanism can be followed.

1. ~~Sharing~~ static.
2. Dynamic

Static Assigment :- priority for task is assigned soon after task creation.

Dynamic Assignment :- priority for task can be changed acc. to run time.

Types of scheduling algorithms :-

1. FIFO
   round robin. (Task switching mechanism).
   ind robin priority.

4. SJF (Shortest job first)
5. preemptive
6. Non-preemptive

Real Time communication protocols:-

RTC consists of software protocols & communication hardware media that provides real time

RTC protocol depend on validity, integrity and timeliness of data transfer.

protocols used are:- 1. websocket :-
. It is standardized by IETF, RFC6455. It provides full Duplex

2. XMPP (Jabber) :- It extensible messaging and precedence protocol. It is based on XML.

3. Web RTC :- Web Real Time communication protocol :-
It is drafted by W3C, to enable browser applications used for voice calling, video chat &

4. Bayeux protocol :- It is used for transporting asynchronous message.
- One way communication messages.
- With low latency b/w web server & web client.

5. Server_Sent Events (SSE) protocol :- used for streaming continous & low latency messages to clients
- Browser API is Called Event Source.

6. Wave Federation protocol :- This is extension of XMPP protocol used in apache ~~fro~~ wave.

7. IRC protocol :- It is used for real time internet text messaging & synchronous conference
IRC is also used for group communication in forums

8. Real Time publish Subscribe protocol :- (RTPS)
designed for used in Synchronize protocol
- Enables best effort, reliable public Subscribe
communication for Real Time Application.

* Real Time Configuration Management :-

Configuration Management is a process of maintaining Systems i.e., is computer S/w & h/w in desired state

It is the method of ensuring, consistent operating system, with expectations over time.

CM identifies updation, re configurations to conform the Systems to desired state.

CM use with IT infrastructure is defined by IT infrastructure library.

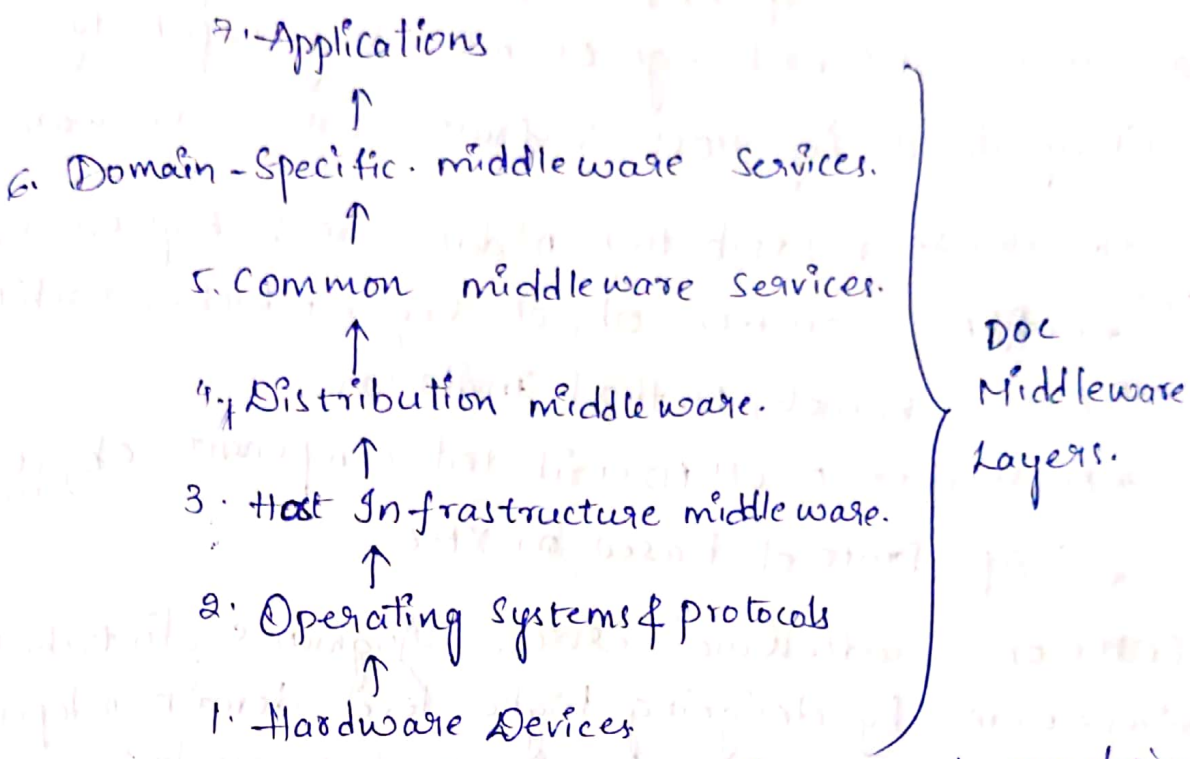
Need for CM :-

* CM uses for preventing undocumented changes from working on their own way in the environment.
* CM helps to rectify performance issues, system inconsistency & compliance issues.

→ CM plan includes a no. of Tools:
1. Classi: Tools enable classification & system management.
2. Tools for Centralized configuration to baseline configuration
3. To automate update
4. To identify problem configuration.
5. To auto mate action prioritization.
6. To Apply remedial actions.

Structure & Functionality of DOC Middleware Actuator:-

DOC stands for distributed object computing.



Middleware: It is the interface connecting Hardware devices and Application layers.

3. Host Infrastructure Middleware.

This layer encapsulates & enhances the huge OS communication and concurrency mechanism to create reusable network components such as reactors, acceptor connector, monitoring objects and Active objects.

Ex :- 1. Sun Java virtual machine.

2. Microsoft platform dot net
   - used for CLR development / common language Rec

3. Adapted communication
   it is responsible for connection establishment, event de multiplexing, inter process communication, static & dynamic, concurrency and synchronization

8. Distribution Middleware :-

This layer levels describe high level programming models consists of useful APIs and components to automate and exchange os networking capability.

* Encapsulated by HOST infrastructure middleware.

Hardware Distribution middleware is Request Broker Architecture

Ex:-
* CORBA - common object Request Broker
* RMI - Remote Method Invitation
* Microsoft's - DCOM - (Distributed component object model)
* SOAP Protocol based on XML

- Common middleware Services :- Augments distributed middleware by designing higher level domain independent Services mainly to concentrate on business logics

Eg:- Microsoft's dot net
CORBA
DJB

Domain Specific Middleware :- This is middleware is to requirements of

Eg:-