IoT → Phenomena that connects variety of things

T-Things - everything that has ability to communicate
It generates data.
1999 → Kevin Asthon, Executive Director of AutoID Center
Iot - term was coined by Kevin Ashton
2008/9 → Actually born.

1000 → 2005 → 2006 → 2008/9
eg Refrigerator plan → ITU → first European IoT conference

↓
International telecommn Union, United Nation first of report on IoT

Evolution.

1) pre-internet

2) Internet of content (www)
   → email / entertainment → smart network

3) Internet of services (Web 2.0)
   → Reproductivity
   → E-commerce.

4) Internet of people
   → facebook.
   → Smartness in phones & apps

5) Internet of things
   → device to device communication, smart devices.

Future:

Smart data

Projection:

2.5 Billion → 30 billion

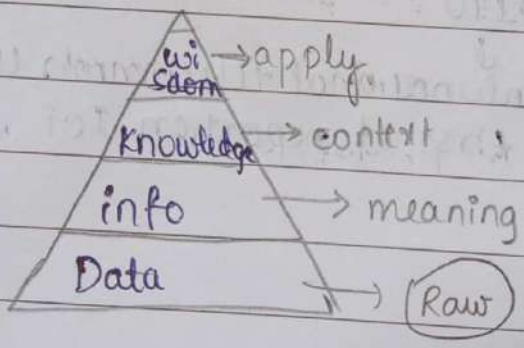
2022

CAGR (compound annual growth rate)

2016 → 2022

16b 30b

10% CAGR.



Application: ① Agri ② Automative ③ Agri ④ Military

Definition:

Dynamic global network infrastructure with self configuring capabilities based on standard and intra operable communication protocols where physical and virtual things have identities, physical attributes and virtual personalities.

and use intelligent interfaces and are seamlessly integrated into info network often communicate data associated with users and their environments

Characteristics:

1) Dynamic & self-adapting
2) Self configuring
3) Interoperable communication protocol
4) Unique identity
5) Integrated into information network.
   → large no. of devices are connected together depending on temp set AC degree
   → IP URI (uniform resource identifier)
   → allows them to communicate & exchange data with others

IoT PROTOCOLS:

→ protocol is a set of rules governing comm'n b/w computers / networks 2 devices

TCP/IP Model.

	IoT stack	Web stack
Network / Link	IEEE 802.15.04 MAC IEEE 802.15.4 PHY 802.3 Ethernet 802.11 wifi	Ethernet, DSL, ISDN, Wifi
Internet	IPV6 / IP Routing 6LoWPAN	IPv6, IPv6, IPsec
Transport	UDP / DTLS	TCP/UDP
Application Layer	CoAP, MQTT, XMPP AMQP, DDS, Web Socket.	HTTP, DHCP, DNS, TLS / SSL
Data format	Binary, JSON, CBOR	HTML, XML, JSON

Link layer.

1) 802.11 Wifi
2) 6LoWPAN - low rate wireless personal area network
3) 802.3 Ethernet, network.
4) 802.16 WiMax
5) 2G/3G/LTE

Network Layer

1) IPV6
2) IPV6
3) 6LOWPAN

IPV6 over low power wireless personal area network

Ap

CoAP - Constraint Application protocol
MQTT - message queuing telemetry transport
XMPP - Extensible messaging & presence
DDS - data dist'n services.
Amqp - advanced message queuing protocol.

I/O interfaces

UART - Universal
SPI - serial peripheral ~~inte~~face
I2C
CAN

Storage

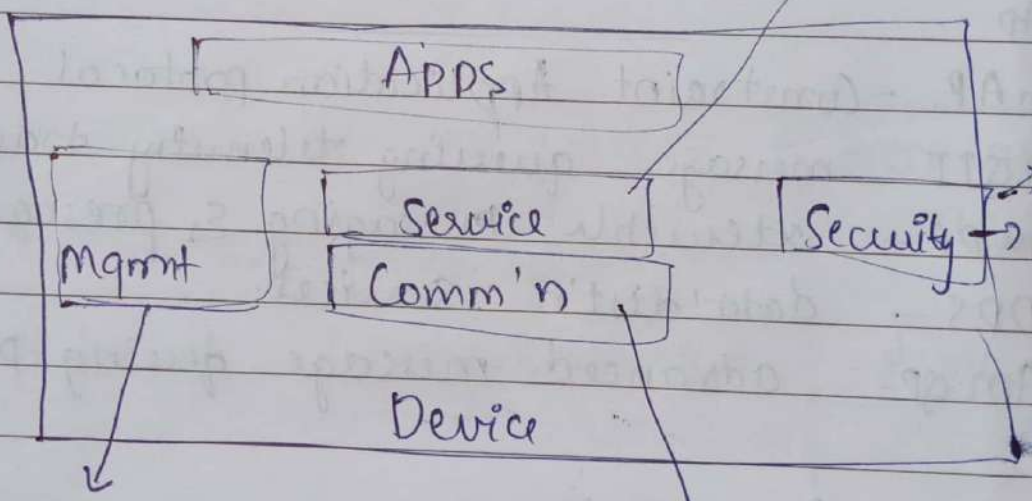
MMC, SD, SDIO

Audio/Video Interface

HDMI 3.5mm Audio RCA video

Connectivity
USB Host
RJ45 / Ethernet.

Memory
NAND / NOR
DDR1/2/3



" control
" publishing
" discovery
device monitoring

→ data security
message &
content
integrity
authenti-
authoriza

functions that
govern entire appl
product

IOT PROTOCOLS

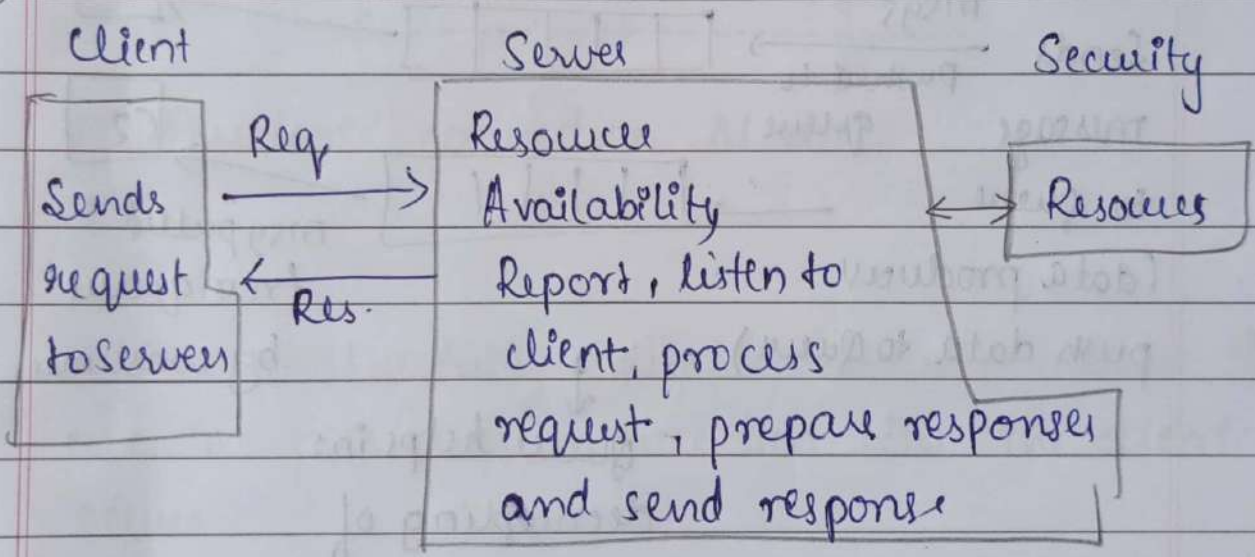
Device - sensors, actuators.

IoT Communication Model

Four models:

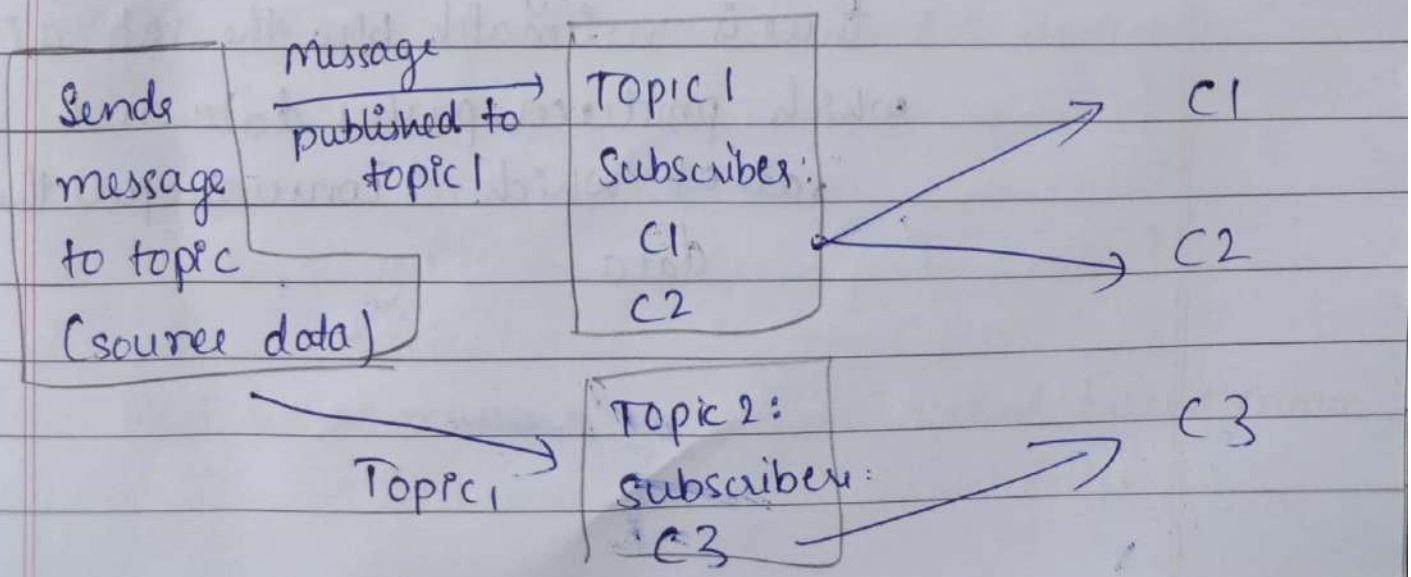
1) Request Response
2) Publish Subscribe
3) Push Pull
4) Exclusive pair

1)



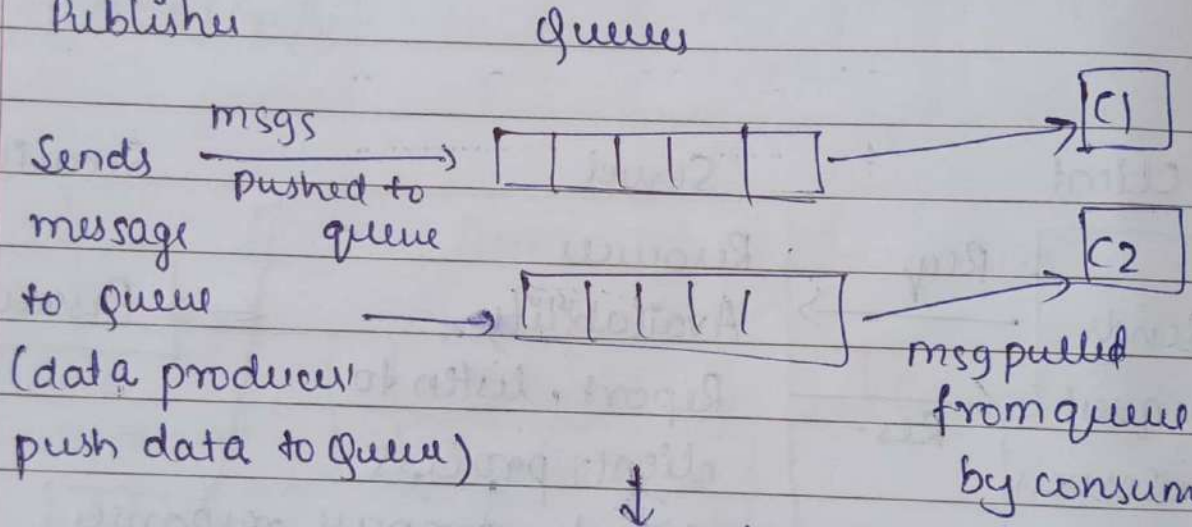
eg: HTML page from HTTP protocol

2) Publisher
Broker
End user



ex: Bitox Server 2004 Integration server that allows develop and deploy & Integrated Business process and XML services manage

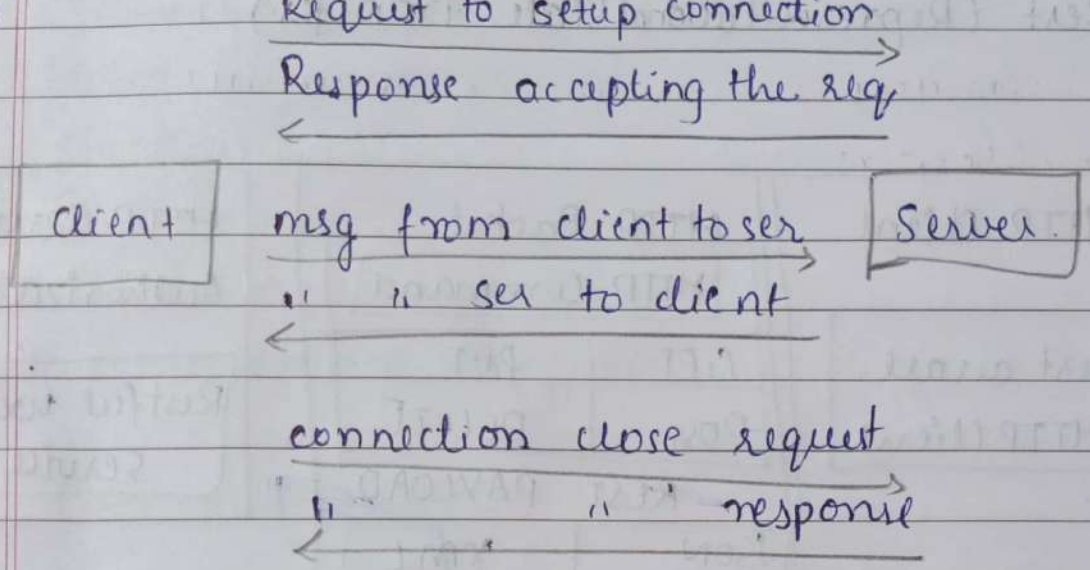
3) Inbox



↕

queue helps in:
decoupling of
msgs b/w producer
&
buffer which helps when
there is mismatch b/w the rate at
which producer pushes data and
rate at which consumer pull the
data.

4)



Persistent connection Model

Bidirectional, fully duplex comm'n model that uses a persistent connection b/w the client & server

IoT Communication API's.

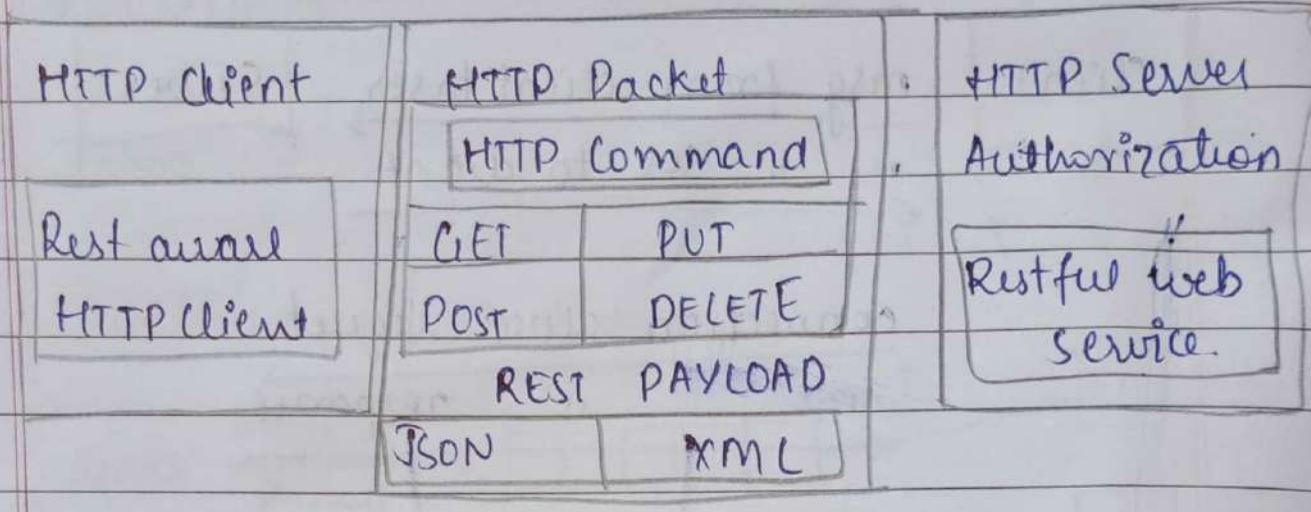
API - points of interaction b/w IoT devices & network

API's

↙ Rest based comm'n API

↘ Web socked based comm API.

Rest (Representational State transfer)



Resources

URI URI

Representations

Resources

Set of architectual principles by which you can design web services and web APIs that focus on system resources and how resource states are transferred and addressed.
Follow Req-Response comm model
Rest architectual constraint apply to Connectors, components, data elements within distributed hypes media system

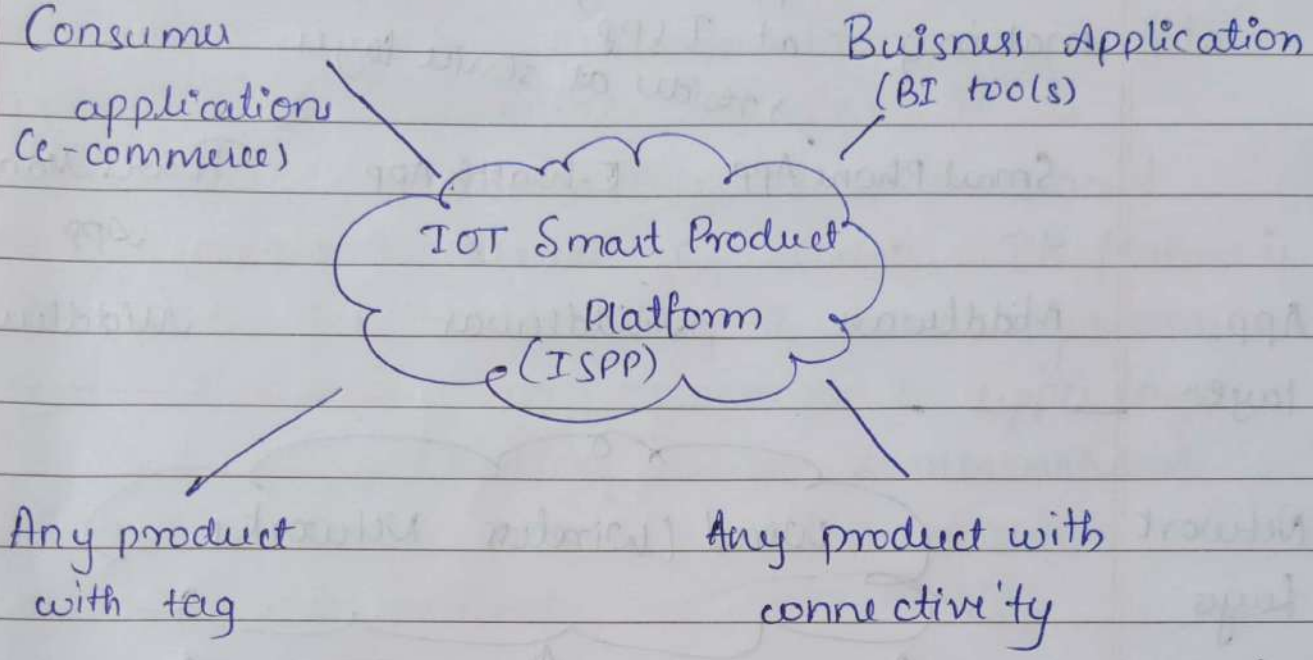
. Constraints:
client - server constraint
stateless
Cacheable
layered system
uniform inteface
Code on demand

2) Web

1) Bidirectional full duplex comm b/w client & server
2) follow exclusive pair
3) Reduces latency, network traffic as there is no overhead for connection setup and teardown.
4) Exchange of data frame shows bidirectional comm's

	Rest	Web Socket
State	stateless	stateful
direction	Unidirectional	Bidirectional.
mode	Req - res	exclusive pair
TCP conne	each request has setting up new TCP connection	single TCP handshake for all incoming req / single TCP connection
overhead	more chances of network overhead	doesn't involve overhead of headers
Scalability	horizontal & vertical	vertical
Cost	low	More

IoT Architecture



One part of consumer & buisness app is connected to common platform which connects IoT smart products. Both apps get connected on undu-lying hardware of IoT SPP. These hardware consists of physical devices that is part of IoT Device may be any product with tag (RFId tags) or any product with capability of comm'n or connectivity. Info generated from undulying layer is gathe ISPP and data

is processed and decision is taken on ISPP and even apps might contribute to decision making at ISPP

↳ reside at service layer.

↳ source of info origin. core layer of IoT. All kinds of info of physical world used in IoT is perceived & collected in this layer It has sensor. It senses some physical parameters or identifies other smart objects in environment

Network layer also called as transport layer that includes access network and core network. It allows transparent data transmission capabilities to IOT. It is responsible for connecting to other smart things, network devices & servers. Its feature is also used for transmitting & processing sensor data the info from perception to upper layers is sent via existing mobile comm network that is called wired/wireless network 4G/5G/LTE network.

Appl'n is called as service layer.

1) data mgmt sub layer
2) app service " "

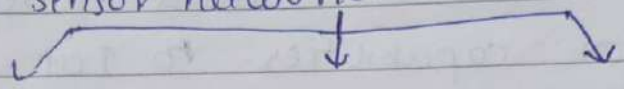
Responsible for delivering app specific services to the user. It identifies various appln in the IOT & that can be deployed.

→ provides processing complex data & uncertain info

Middleware helps comm'n b/w L2 and L3 3-layer architecture of IOT protocol stack

Enabling Technologies

1) Wireless sensor network.



no. of end nodes routers co-ordinators.

→ distributed devices made of sensors used to monitor environmental & physical condition.

2) Cloud Computing → a network of

→ practice of using remotes servers hosted on Internet to store, manage & process data rather than local server or pc

Acess resource virtually
↳ storage, mgmt, processing

→ IaaS (capability to consumer to hire infrastructure components such a server, storage & network Ex: AWS, google Cloud)

→ PaaS

→ SaaS → Google form

G " " " " to use CSP app running in cloud infra

→ capability to consumer to deploy consumer created/acquired app on CSP infrastructure
Ex: Online IDE.

3) Big Data Analytics

It is collecting, organizing & analysing large set of data called Big Data to discover pattern & other useful info.
Collected at data warehouse.
Characteristics (3V of data)
↳ variety velocity volume
↓ ↓ ↓
structured speed at Tera/Peta.
" data is
semi " processing

Sensor sense actuator reacts to sensors.

Sensor control center Actuator.
(Temperature ↗ process if ↑ turn on
Sensor) → heat

1) Temperature sensor
2) Proximity sensor - detects presence of nearby objects
Optical " light to electronic signals
Pressure "
Humidity - moisture, temperature
accelerometer, gyroscopic " - measure acceleration forces
smoke