UNIT 5 - UBIQUITOUS CLOUDS AND IOT

CLOUD TRENDS IN SUPPORTING UBIQUITOUS COMPUTING

'Ibiquitous Computing / Pervasive computing / ubicomp = Computing anywhere, anytime

Ubiquitous computing refers to the integration of computational capabilities into everyday objects and environments, enabling computing to occur at anytime, in any place and often without direct user interaction.

Cloud enables: On-demand resources, Device independance, Auto-scaling, Mobility.

Cloud Mashup

It is web application that combines data, presentation or functionality from multiple cloud-based sources (API's, services, database).

Mashup drive Agility : → speed + flexibility

1) Rapid Customization - combine existing services/API to create solutions quickly.
2) Faster Development - use pre-built cloud components → rapid prototype & deploy.
3) Flexible Integration - Easily mix services like mapping, analytics, etc.

Mashup drive Scalability : → handle more users or data without performance drop

1) On-demand Scaling - mashups can use extra compute/storage dynamically.
2) Load distribution - workloads can be spread across multiple services → less downtime
3) Cost efficiency - pay only for what you use.

Benefits : Innovation, UX, Global Reach (aggregate services across geographic regions).

Use case : Business dashboard (integrating sales, inventory, & customer data)

Mobile Cloud Computing

MCC → using cloud computing to offload heavy processing & storage from mobile devices.

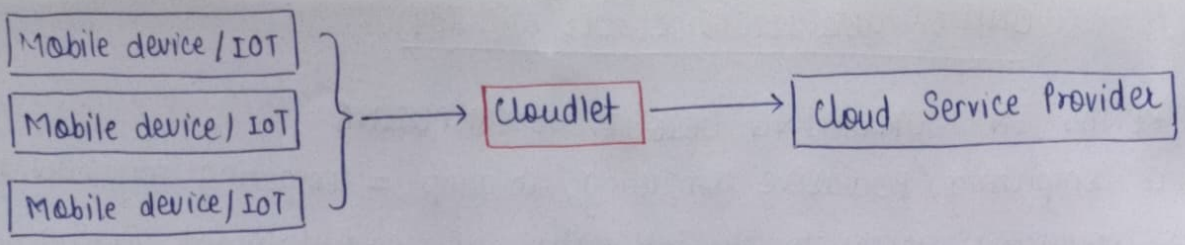
Issues in MCC → Mobile device have limited computing power.
→ Battery drain, Bandwidth & Latency issues.

Solution: Cloudlet (nearby helper for quick, heavy processing)

Cloudlet is a small-scale data center located near the user. It provides low-latency high bandwidth cloud computing services to mobile devices.

Why use Cloudlet ? Popularity of mobile devices = require high performing processing tasks → but computational resource of Mobile devices is limited (memory, battery life, heat) → so solution is cloud computing → but again, cc is expensive roaming charge → growing demand for radio access → so FINALLY !! its cloudlet → Benefits in faster response time, efficient resource allocation, scalability, flexibility, improve UX.

Aspects	Location	Latency	Bandwidth usage	Connectivity	Users	Target devices	eg.
Cloud	cetralised (far from user)	High	High (far)	Over the internet	worldwide	PC, servers, large systems	AWS, GoogleCloud
Cloudlet	edge (near to user)	very low	Low (local processing)	LAN, wifi	local users	Mobile device, IoT	servers at cafes



PERFORMANCE OF DISTRIBUTED SYSTEMS AND THE CLOUD.

Performance Metrics

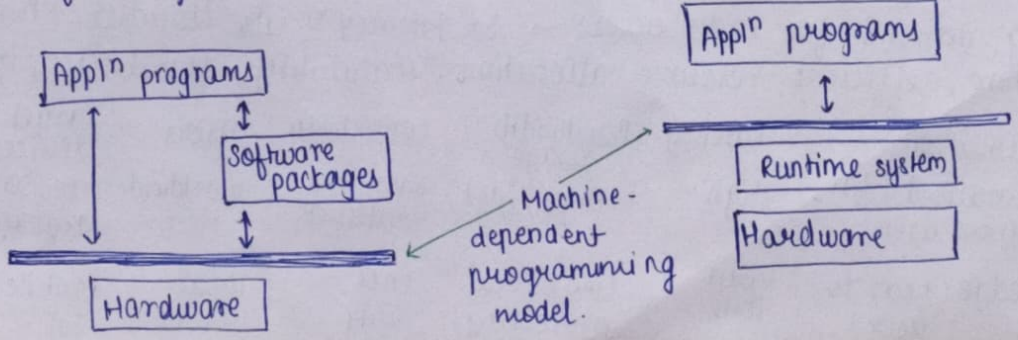
Latency → Time delay in data communication/response. Lower is better.
Throughput → Amount of data processed in given time. Higher is better.
Scalability → Ability to handle increasing workload by adding resources.
Reliability → System's ability to work continuously without failure.
Availability → Uptime / ~~Redi~~ Readiness of system services.
Fault Tolerance → Ability to continue operation even if parts fail.

Data-Intensive Scalable Computing (DISC)

- DISC is a computing paradigm designed to efficiently manage, process and analyze large volumes of data (Big data) across distributed systems, mainly using cloud-based infrastructures.
- DISC systems use clusters of interconnected computers to distribute both storage and computing, allowing for parallel processing & linear scalability.
- Essential for appln in Big data analytics, scientific research, and large-scale web services.

Aspects	Supercomputers	DISC
Data location	Data is taken from far away (slow and heavy)	Data is already nearby (fast, no extra movement).
Movement overhead	lots of data shuffling (more time & cost)	No need to move data around (efficient)
Execution	Runs programs specific to one machine (needs experts)	Runs programs that work anywhere (system handles load, balance)
Usage	Works in batch mode (when all resources are ready)	Supports interactive use (multiple users can access at same time)
Fault Tolerance	less	More
Maintainance	Needs to be shut down to fix things (downtime)	Keeps running even during problems, using backup methods

Diagram



The Internet of Things (IoT) is a collection of diverse technologies that interact with physical world.

1) RFID (Radio frequency Identification)

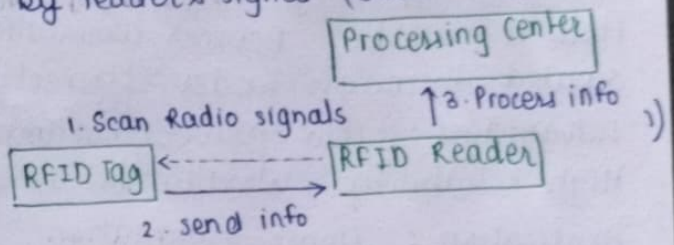
What is it? Uses radio waves to automatically identify and track tags attached to obj.

Components: Tag - Attached to the object, stores unique ID/data.
Reader - Sends radio waves to tags, receives data from tags.
Antenna - Helps send & receive radio signals.

Working: The reader sends out radio signal → tag's antenna pick up signal → tag sends back its stored data → reader processes this info.

Types of tags: Active tag → Battery-powered (long range).
Passive tag → No Battery, powered by reader's signal (short range).

Applications → Toll collection and vehicle tracking
→ Tracking baggage & passports.
→ Security badges
→ Inventory management at super markets.

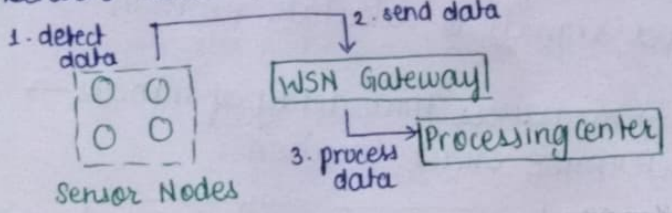


2) Wireless Sensor Networks (WSN)

What is it: Network of tiny sensor nodes/devices that monitor/sense physical conditions (like humidity, wind speed, movement of people, etc).

Components: Sensor Nodes - small devices with sensors, microcontrollers, radio transceivers, and power sources (usually batteries).
(Gateway) Base stations - collects data from sensors & sends it to central computer.

Working: Sensor node detect data → send data wirelessly to base station → data processed for monitoring.



Features: Self organizing
Energy efficient to prolong battery life.
Scalable to 1000's of nodes.

Application: Environment monitoring (fire, pollution)
Health monitoring (vital signs)
Smart Homes (temperature, smoke)

RFID Continued...

Pyq Difference betn Active & Passive tag (8 mks)

Aspects	Active RFID Tag	Passive RFID Tag
Power source	Has own Battery	Is Powered by RFID reader signal.
Signal Range	Long (100+ m)	Short (3-10m)
Signal Strength	Strong	Weak
Size	Large	Small & lightweight
Cost	More	Less
Data storage	More	Limited
Battery life	Limited	No battery (Unlimited)
Applications	Tracking vehicle, containers, toll, etc.	Inventory, Retail, access cards, lib books

3) Zigbee. Operates at 2.4 GHz Band frequency.

What is it: Zigbee is a very low-cost, very low-power consuming, two-way, wireless communication protocol / standard based on IEEE 802.15.4 standard.

Components: Coordinator – initialize and maintain devices on the network. Stores network info (security keys and routing tables). Only 1 coordinator. It assigns network addresses to other devices.

Zigbee Router – These extend network by serving as middleman. They send and receive data from various networks and route the network traffic. They are used in tree and mesh topologies. smart plug, smart siren

Zigbee Enddevices – Actual IoT devices. They send data to the parent device which could be Zigbee coordinator or router.

Network topology: Supports star, tree and mesh.

How it works: Devices communicate with each other in a network → data packets routed through nodes efficiently → coordinator manages network.

Advantages: Low power consumption, Simple and cost effective, High Usability, High Reliability, Worldwide acceptance, High security.

Application: Home automation
Smart energy (meters)
Security systems
Health care devices.

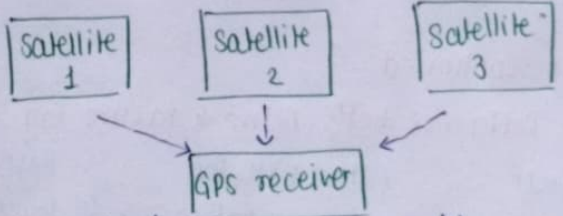
4) GPS (Global Positioning System)

What is it: A satellite based navigation system that provides geolocation and time information anywhere on Earth.

Components: Satellites - transmits signals continuously
GPS receivers - devices that receives signals & calculate position.

Working:
GPS receiver picks up signal from multiple satellites → measures time delay of signals → calculates distance to each satellite → uses to determine exact location.

Application: Vehicle & fleet tracking
Navigation
Asset & Personnel tracking.



Imp observation * Role in IoT

RFID - enables automatic identification, tracking without direct line of sight

WSN - enables real time data collection and remote monitoring

ZigBee - ideal for connecting devices in mesh networks. Its low power consumption & ability to support large device networks made it popular in IOT.

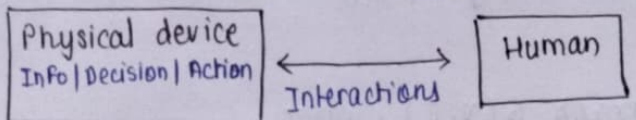
GPS - enables precise geolocation of devices and assets.

INNOVATION APPLICATION OF IOT

1) Smart Buildings - Any structure that uses IoT to automate control of building's operation (heating, ventilation, lighting, security, etc).
Benefits: Saves energy, Improves comfort, enhance safety.
Features: Smart locks and surveillance, energy efficient systems, climate control

2) Smart Power Grid - Modernised grid that enables bidirection flow of energy. and uses two-way, communication & control capabilities that creates new applications.
- A smart Grid uses IoT sensors, smart meters and automation to monitor, predict and efficiently manage power generation, distribution and consumption.
Need: Increasing demand for electricity. (Modern lifestyle, EV, ACs, etc)
Integration of Renewable Energy. (need to manage variable sources like Solar and wind, ensuring stable and balanced energy supply).
Outdated Infrastructure (existing systems are old and lack automation)
Key Components: Smart Meters, IoT sensors & Controllers, communication Network, Control Centers.
Features: Real time monitoring, self healing (fault detection), load balancing, Two way communication.
Conclusion: Smart Grids are essential for a reliable, cost effective & sustainable future energy system.

3) Cyber - Physical Systems (CPS) - smart systems that use embed computing intelligence into regularly used physical objects.
Examples: Self driving cars, Industrial robotics, Smart healthcare device.
Components: Physical Devices - has computing power, sensors, mechanisms. It provides info, take decisions and carry out actions.
Interactions - physical interface (touch, press, rotate).
Human - interacts with CPS.



* Has feedback loop betn physical and digital systems.

IoT and CPS are interlinked. CPS often relies on IoT devices to gather data from the physical world, which it then uses to make decisions and control systems. So CPS uses the info from IoT to perform its functions
Analogy: IoT (nerves) and CPS (brain)

4) Retail and Supply Chain Management (SCM)
Retail - sale of goods/services. IoT brings digital intelligence, helping stores improve customer experience, streamline operations and managing inventory effectively.

1) Smart Inventory Management.
- Uses RFID tags and IoT sensors to track product quantities in real time.
Appln: Automatically updates stock levels, alerts staff to restock and prevents stockouts or overstocking.

2) Customer Experience Enhancement
- IoT cameras and motion sensors monitor customers behaviour inside the store.
Appln: Analyzes customer preferences to rearrange products or give real-time offers, improving satisfaction.

Supply Chain management - planning, execution and monitoring of all proces involved in moving goods from suppliers to customers.

1) Real Time Asset Tracking
- GPS and RFID embedded tags attached to goods track location continuously.
Appln: Enables companies to monitor shipment status, avoid delays.

2) Route Optimization & Scheduling
- IoT devices analyze traffic, weather, and delivery urgency.
Appln: Suggest best routes, reduce delivery time & fuel consumption.

ONLINE SOCIAL AND PROFESSIONAL NETWORKING

Refers to use of digital platforms to connect, communicate and build relationships with others for social or career-related purposes.

Social Networking: used for - making friends, sharing updates, photos, videos.
eg - facebook, Twitter, Instagram, Snapchat.
Features - posts, comments, likes, stories, messaging, groups.

Professional Networking: used for - Job search, career growth, connecting with professionals.
eg - LinkeIn, Github, ResearchGate
features - Resume sharing, professional posts, job listing

Graph Properties of Social Networks.

1) Social Network can be represented as a graph $G(V, E)$, where
V = Finite set of Vertices = People
E = Finite set of Edges = Friendship (Followers)

2) Directed Graphs - relationships are mutual (facebook friends).
Undirected Graphs - relationships are one way (Twitter followers).

3) Degree of node = no. of connection it has
Social networks often have power law degree distribution, meaning most nodes have few connections, but few nodes have many. Use - Popularity of user

4) Path Length - distance between 2 nodes (short) Use - search, message routing.

5] Density = the proportion of possible connections in the network that are actually present.
Social networks have low density.
Use - Network reach & strength

Benefits of Social & Professional Networking

1) Access to Job opportunities
2) Career Growth & Development
3) Knowledge sharing & Fresh Ideas
4) Awareness
5) Communication
6) Collaboration
7) Opportunities access
8) Strong Business & Personal connections.

PYQ

Twitter - founded in 2006, is a microblogging social network focused on sharing short messages called 'tweets' with maximum of 280 characters.
Key aspects:

1) Following Model - users can follow anyone, making it easy to access info.
2) Tweets & Retweets - users can post tweet that appears in follower's feeds; can retweet posts and add comments, likes.
3) Hashtags (#) & Mentions (@) - Hashtags categorize tweets by topic, making them searchable; Mentions tag other users to involve them in convo.
4) Direct Messaging - Private message allow users to communicate directly
5) Trending Topics - Twitter highlights popular & emerging topic based on users activity and location
6) Real Time Information - sharing news, opinions, updates quickly.

Facebook - Launched in 2004, that allows users to connect with friends, family and communicate worldwide.
Key aspects:

1) Profile and Timelines
2) friends and connections
3) Feed
4) Groups and Pages
5) Messenger
6) Live Video & Stories
7) Advertisements.
8) Mentions and Hashtags
9) Trending Topics.