Internet of Things (IoT) and Resource Management – Revision Notes

IoT Quick Revision Notes

Definition of IoT

- **Internet of Things (IoT)**: A system of **interconnected physical objects** that collect and exchange data using **networking technologies**.
- It integrates **real-world data and services** into current **information networks**.

Basic IoT Architecture

1. **Things**: Sensors/devices that gather data.
2. **Gateway**: Bridges devices and cloud, handles data preprocessing.
3. **Network & Cloud**: Data transmission, storage, and processing.

Features of IoT

- Infrastructure is **abstracted from the user**.
- **Cloud computing** stores data/services remotely but accessible **anywhere**.
- Works on **economies of scale**.

Applications of IoT

- **Domestic**, **Industrial**, **Health**, **Commercial**, **Government sectors**.
- IoT faces challenges in **scale, speed, security, safety, and privacy**.

Cloud & IoT Integration

- Cloud provides **flexible**, **scalable**, and **remote resources**.
- Ideal for **data storage**, **analysis**, and **centralized processing**.

Challenges in Cloud-Only IoT

- Not ideal for **time-sensitive** applications.
- **Bandwidth-intensive** data transmission from sensors to cloud.
- **Latency** and **network congestion**.

Fog and Edge Computing

- Process data **closer to the source**.
- Reduce **latency** and **improve response time**.
- **Supports cloud**, not replaces it.

Three-layer model:

- **Client (Edge)** → **Fog Layer** → **Cloud Layer**.

Components of Fog Layer

- **Fog Server Manager**: Allocates processors.
- **Virtual Machines (VMs)**: Process and return results.
- **Fog Servers**: Host both manager and VMs.

Resource Management Approaches

Architectures:

- **Data Flow**: Direction of data/workload movement.
- **Control**: Centralized or distributed resource control.
- **Tenancy**: Hosting single/multiple apps on nodes.

Infrastructure:

- Hardware: Routers, APs, home servers, laptops, smartphones.
- System Software: OS, virtualization.
- Middleware: Coordinates VMs, containers.

Key Mechanisms:

- **Discovery**: Identifying edge resources.
- **Benchmarking**: Performance measuring.
- **Load Balancing**: Optimizing task distribution.
- **Placement**: Mapping tasks to resources based on availability and conditions.

Service/Application Placement

- Application placement = mapping services to **infrastructure graph** (nodes + links).
- Must satisfy:
    - **Resource constraints**: CPU, RAM, bandwidth.
    - **Network constraints**: Latency, bandwidth.
    - **Application constraints**:
        - **Locality**: Restricted location.
        - **Delay Sensitivity**: Deadlines for execution.

Offloading

- Moves **applications/data** to edge for performance and speed.

Types:

1. **User Device → Edge**:
   - Enhances device computing.
   - Uses **partitioning** and **caching**.
2. **Cloud → Edge**:
   - Shifts workloads closer to user.
   - Uses **server offloading** and **caching**.

KEY TERMS for MCQ (High probability questions)

Term	Definition
IoT	Network of interconnected physical objects with sensing and communication capabilities
Fog Computing	Decentralized computing at network edge, closer to data source
Edge Computing	Processing done at or near data source for low latency
Gateway	Bridge between IoT devices and cloud
Cloud Computing	Scalable, remote data and service access
Latency	Delay between data request and response
VMs (Virtual Machines)	Virtual environments for processing tasks in fog/cloud
Resource Management	Allocation and scheduling of compute, storage, and network
Load Balancing	Efficient task distribution across nodes
Offloading	Moving computation from cloud or device to edge