Week 1 Concepts: Explanation and Summary

OSI Layers: Mapping to Real Protocols

The OSI model defines seven layers for network communication:
1. Physical – Hardware (Ethernet cable, Wi-Fi)
2. Data Link – MAC addressing (Ethernet, Wi-Fi)
3. Network – IP routing (IP, ICMP)
4. Transport – End-to-end delivery (UDP, TCP)
5. Session – Session management (NetBIOS)
6. Presentation – Data encoding (SSL, JPEG)
7. Application – User interface (HTTP, DNS)

In our UDP chat app:
- Layer 4: We use UDP for sending messages.
- Layer 7: We type/read messages from the user.

State Machine

A state machine is a control system with defined states and transitions.
Each state responds to inputs (events) and may move to another state.
In our chat app, states could be IDLE, SENDING, and RECEIVING.

Events, Array, Pointers

Events: Trigger actions (e.g., key press, packet received).
Arrays: Fixed-size containers for data (e.g., buffer[1024]).
Pointers: Variables storing addresses of other variables. Used for dynamic memory and function callbacks.

RTOS vs Superloop

RTOS: Real-Time Operating System. Supports tasks, preemption, scheduling (e.g., FreeRTOS).
Superloop: Simple infinite loop. All tasks run in sequence. Easier but less flexible.

Scheduler, Threads

Scheduler: Selects which thread/task runs next based on priority.
Threads: Independent units of execution. Allow multitasking within a program.

Data Structures: Queue, Linked List, Circular Buffer

Queue: FIFO structure, useful for buffering data.
Linked List: Nodes connected by pointers. Allows dynamic insertion/removal.
Circular Buffer: Ring structure used in UART and network buffers.

Pointers: Structure/Function Pointers, Callback Functions

Structure Pointer: Access struct members via pointer (e.g., ptr->value).
Function Pointer: Store address of a function, call dynamically.
Callback: A function passed to another function to be called later.

Bit Operations & Byte Packing

Bit operations: Used to manipulate bits (e.g., masking, shifting).
Byte packing: Combine multiple values into a byte/word (e.g., (high<<8)|low).
Useful in low-level embedded systems and protocols.