# 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.