**Uart communication – chatGPT**

**Transmission (Sampling):**

In UART communication, bits of data are transmitted in sequence, meaning one bit is transmitted at a time. This is because UART is a serial communication protocol, where data is transmitted sequentially over a single communication channel.

To transmit a byte of data, which consists of 8 bits, the sender transmits each bit sequentially, starting with the least significant bit (LSB) and ending with the most significant bit (MSB). The sender transmits the bits one at a time, with a fixed time delay between each bit.

The time delay between each bit is determined by the baud rate, which is the number of bits transmitted per second. For example, if the baud rate is 9600 bits per second, then each bit takes approximately 104 microseconds to transmit (1/9600 seconds per bit). This delay between each bit is necessary to allow the receiver to sample the incoming signal at the correct times and accurately decode the transmitted data.

During transmission, each bit is represented by a voltage level on the communication channel. A logic high voltage level typically represents a binary 1, while a logic low voltage level represents a binary 0. The sender transmits each bit by setting the voltage level on the communication channel to the appropriate level for a fixed amount of time, which is determined by the baud rate.

Overall, transmitting bits in sequence is a fundamental aspect of UART communication. The sender transmits each bit sequentially, with a fixed delay between each bit, and the receiver samples the incoming signal at the correct times to decode the transmitted data. Any errors or timing issues in the sequence of transmitted bits can result in errors in the received data.

**Receiver (Sampling):**

In UART communication, the receiver must accurately sample the incoming signal to determine the value of each transmitted bit. The timing of each sample is critical, and a timing error of even a few microseconds can cause the receiver to misinterpret the value of the bit being transmitted.

To ensure accurate sampling, the receiver typically uses a clock signal that runs at the same baud rate as the transmitter. The clock signal is used to trigger the sampling process at specific times, which correspond to the middle of each bit time.

When the transmitter transmits a bit, it sets the voltage of the signal to a specific level for a certain amount of time to indicate whether the bit is a 0 or a 1. The receiver must sample the signal during the stable portion of the bit time to accurately measure the voltage level. Sampling too early or too late can result in an inaccurate measurement.

One common way to sample the incoming signal is using a technique called edge sampling, where the receiver samples the voltage level of the signal at the moment of the transition edge. In other words, the receiver measures the voltage level of the signal at the exact moment when the voltage level changes from high to low or low to high.

To do this, the receiver typically uses a flip-flop circuit that is triggered by the clock signal. When the flip-flop is triggered, it captures the voltage level of the incoming signal and holds it until the next clock signal arrives. By sampling the signal at the transition edge, the receiver can accurately determine the value of each bit being transmitted.

Another technique for sampling the incoming signal is called center sampling, where the receiver samples the signal in the middle of each bit time, when the signal is expected to be stable and not transitioning. This method requires more accurate timing synchronization between the transmitter and receiver and can be more susceptible to timing errors.

In summary, accurate sampling is critical for reliable UART communication. The receiver typically uses a clock signal that runs at the same baud rate as the transmitter and uses edge or center sampling techniques to accurately measure the voltage level of the incoming signal.