**Topic: Automatic Repeat Requests (ARQs)**

Reading Time: 15 mins

**·        Note\* Highlight important/core points while reading**

·        Read the content and write the answers given in the document in your words, to get the solid grip on topic.

**Automatic Repeat Requests (ARQs)**

Automatic Repeat Requests (ARQs) are error-control protocols used in data transmission to ensure data integrity and reliability. ARQ systems detect errors and request retransmission of corrupted or lost data packets, enhancing communication accuracy. ARQs are essential in networks where data reliability is crucial, such as Wi-Fi, cellular networks, and satellite communications.

**Working of ARQs**

ARQ protocols use acknowledgments (ACKs) and timeouts to detect and correct errors:

1. **Data Transmission**: The sender transmits a data packet to the receiver.
2. **Acknowledgment (ACK)**: Upon successful reception, the receiver sends an acknowledgment (ACK) back to the sender, confirming that the packet was received correctly.
3. **Timeout**: If the sender does not receive an ACK within a set period (timeout), it assumes that the packet was either lost or corrupted and retransmits it.
4. **Negative Acknowledgment (NACK)**: In some systems, if the receiver detects an error in a packet, it sends a negative acknowledgment (NACK), prompting the sender to resend the specific packet.
5. **Sequence Numbers**: To avoid confusion between packets, sequence numbers are used, ensuring that the sender and receiver can keep track of each packet accurately.

**Categories of ARQ Protocols**

1. **Stop-and-Wait ARQ**:
   * The sender transmits one packet and waits for an acknowledgment before sending the next packet.
   * Simple but inefficient for high-latency networks.
2. **Go-Back-N ARQ**:
   * The sender can send multiple packets without waiting for individual acknowledgments.
   * If an error is detected, all packets starting from the erroneous one are retransmitted.
3. **Selective Repeat ARQ**:
   * The sender sends multiple packets, and only erroneous packets are retransmitted.
   * More efficient as it reduces unnecessary retransmissions.

**Benefits of ARQs**

* **Reliability**: ARQs ensure that data received by the receiver is correct and complete.
* **Data Integrity**: ARQs help in detecting and correcting errors, ensuring data integrity.
* **Efficiency**: ARQ protocols like Go-Back-N and Selective Repeat improve transmission efficiency over large networks.

**Limitations of ARQs**

* **Latency**: Retransmissions can introduce delays, especially over long distances.
* **Bandwidth**: Retransmissions consume bandwidth, which can slow down other network activities.
* **Complexity**: Protocols like Selective Repeat are complex and may require additional memory and processing.

### ****A-Rated Questions/Answers By Examiner****

**Q1**: **Describe the purpose of Automatic Repeat Requests (ARQs) in data transmission.**  
**Answer**: ARQs ensure reliable data transmission by detecting errors and requesting retransmission of lost or corrupted packets, helping maintain data integrity and accuracy.

**Q2**: **How does a "Stop-and-Wait" ARQ protocol work?**  
**Answer**: In Stop-and-Wait ARQ, the sender transmits one packet and waits for an acknowledgment before sending the next packet. If no acknowledgment is received within a timeout period, the sender retransmits the packet.

**Q3**: **Explain how the "Go-Back-N" ARQ protocol improves efficiency compared to Stop-and-Wait ARQ.**  
**Answer**: Go-Back-N ARQ allows the sender to send multiple packets without waiting for acknowledgments after each one. If an error is detected, only packets from the erroneous one onward are retransmitted, saving time.

**Q4**: **What role do sequence numbers play in ARQ protocols?**  
**Answer**: Sequence numbers help both the sender and receiver keep track of packets, preventing confusion and ensuring that retransmissions can be correctly identified and ordered.

**Q5**: **Describe the main advantage of Selective Repeat ARQ over Go-Back-N ARQ.**  
**Answer**: In Selective Repeat ARQ, only the specific erroneous packets are retransmitted, rather than all subsequent packets, which improves efficiency by minimizing retransmissions and reducing bandwidth usage.

### Write your Answers on your Notebook and Verify it on Next Screen

**Q6**: What is the purpose of using acknowledgments (ACKs) and negative acknowledgments (NACKs) in ARQ protocols?

**Q7**: How does the timeout mechanism help in detecting errors or lost packets in ARQ protocols?

**Q8**: What is one major drawback of the Stop-and-Wait ARQ protocol in high-latency networks?

**Q9**: In what type of network conditions would Selective Repeat ARQ be more advantageous than Go-Back-N ARQ?

**Q10**: Why might ARQ protocols be limited in scenarios requiring real-time data transmission?

**6. Answer**: ACKs confirm that a data packet has been received correctly, while NACKs indicate an error in the received packet. This system allows the sender to resend only the necessary packets, ensuring accurate data transmission.

**7. Answer**: If an acknowledgment (ACK) is not received within a specific timeout period, the sender assumes the packet was lost or corrupted and retransmits it. This helps prevent data loss due to transmission errors.

**8. Answer**: The Stop-and-Wait ARQ protocol can be inefficient in high-latency networks because the sender must wait for an acknowledgment before sending the next packet, causing delays in data transmission and reducing throughput.

**9. Answer**: Selective Repeat ARQ is more advantageous in networks with higher error rates, where individual packet errors occur frequently. By retransmitting only erroneous packets, it reduces bandwidth usage and improves efficiency.

**10. Answer**: ARQ protocols can introduce delays due to retransmissions and timeouts, which may interfere with the timing requirements of real-time data applications, such as video calls or live streaming, where low latency is critical.