**Topic: The need to check for errors**

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.

**Error Detection Techniques in Data Transmission**

Data transmission errors can occur due to noise or interruptions in communication channels. Error detection techniques like **echo check**, **checksum**, and **parity check** (including parity bit, parity block, and parity byte) are used to detect these errors, ensuring the integrity of data being transmitted.

**1. Echo Check**

**Working**: In echo checking, the receiver sends the received data back to the sender. The sender then compares this echoed data with the original. If the data matches, the transmission is considered error-free; otherwise, an error is detected.

**Categories**:

* **Advantages**: Simple and effective for detecting errors.
* **Limitations**: Limited to detecting errors on the sender's side and is inefficient for large data transmissions.
* **Applications**: Suitable for short messages or low-priority transmissions, often in basic communication protocols.

**2. Checksum**

**Working**: A checksum is calculated by adding all segments of data, generating a single value. This value, known as the checksum, is sent alongside the data. Upon receiving the data, the receiver calculates its own checksum. If the checksums match, the data is assumed correct; if not, an error is detected.

**Categories**:

* **Advantages**: Effective for detecting errors in large data sets, as only the checksum value needs to be transmitted.
* **Limitations**: May not detect some types of errors if they don’t alter the overall checksum.
* **Applications**: Commonly used in network transmissions (like TCP/IP) and data storage to verify data integrity.

**3. Parity Check**

**Working**: A parity check adds an extra bit, called the parity bit, to data to make the count of 1s either even (even parity) or odd (odd parity). The receiver checks this parity bit to determine if any single-bit error occurred. Parity checks can be further broken down into **parity blocks** and **parity bytes** for enhanced accuracy.

**Parity Bit**

* **Working**: A single parity bit is added to each byte of data to make the total number of 1s even or odd.
* **Application**: Often used in simple error detection schemes for small data units, like single characters or bytes.

**Parity Block**

* **Working**: A block of data, arranged in a grid, includes parity bits for both rows and columns, allowing detection of multi-bit errors within the block.
* **Application**: Suitable for memory storage and larger data transfers where error detection across multiple bits is necessary.

**Parity Byte**

* **Working**: An entire byte is dedicated to parity, representing the combined parity of multiple data bytes.
* **Application**: Useful in systems that need stronger error detection across byte-level data segments.

**Categories**:

* **Advantages**: Effective for single-bit error detection and can be extended to multi-bit error detection with parity blocks.
* **Limitations**: Limited error detection capability, especially with multiple bit errors in basic parity bit schemes.
* **Applications**: Commonly used in RAM, data storage, and communication protocols where simple error detection is sufficient.

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

**Q1**: **Describe the purpose of an echo check in data transmission.**  
**Answer**: The purpose of an echo check is to detect errors by having the receiver send the data back to the sender. The sender then compares the returned data with the original to verify accuracy. If they match, no errors are detected.

**Q2**: **How does a checksum detect errors in transmitted data?**  
**Answer**: In a checksum, data segments are summed to create a checksum value, which is sent with the data. The receiver recalculates the checksum and compares it with the received one. If they match, the data is assumed to be correct; otherwise, an error is detected.

**Q3**: **Explain the difference between even and odd parity in a parity check.**  
**Answer**: Even parity adds a bit to ensure the total number of 1s is even, while odd parity adds a bit to make the total number of 1s odd. This helps in detecting single-bit errors by checking the expected parity.

**Q4**: **What is a parity block, and how does it enhance error detection?**  
**Answer**: A parity block is a grid of data with parity bits for each row and column. This structure helps detect errors across multiple bits, providing better accuracy for error detection than a single parity bit.

**Q5**: **Why is a parity byte useful in error detection?**  
**Answer**: A parity byte is used to hold the parity of multiple data bytes, providing a way to detect errors across larger data sections. It’s particularly useful for detecting errors when managing data at the byte level.

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

**Q6**: What are the advantages and limitations of using an echo check for error detection in data transmission?

**Q7**: How does a checksum help ensure data integrity during transmission, and what are its limitations?

**Q8**: In what situations would a parity block be more effective than a single parity bit for error detection?

**Q9**: Why might checksum error detection be preferred over parity checks in network communications?

**Q10**: How does the addition of a parity bit help in detecting single-bit errors in data transmission?

**6. Answer**: **Advantages**: Simple and effective for detecting errors, especially in small data transmissions.

* **Limitations**: Limited to detecting errors on the sender's side, inefficient for large data transmissions, and may not be suitable for complex error scenarios.

**7. Answer:**A checksum works by adding data segments to generate a value, which is transmitted with the data. The receiver recalculates the checksum and compares it to the received value to detect errors.

* **Limitations**: May not detect some types of errors, especially those that do not alter the checksum value.

**8. Answer:**A **parity block** is more effective than a single parity bit in situations where larger amounts of data need to be checked for errors, such as in memory storage or multi-bit data transfers. It detects errors across multiple bits within a data grid, improving accuracy in error detection.

**9. Answer: Checksum** error detection is preferred over **parity checks** in network communications because it can detect errors in larger data sets by transmitting a single checksum value, rather than having to check each individual byte or bit. It is more efficient for larger data volumes, such as in network protocols like TCP/IP.

**10. Answer**: The addition of a **parity bit** ensures that the total number of 1s in a byte of data is either even or odd, based on the chosen parity type. If the parity is not as expected (e.g., even or odd), it indicates that a single-bit error has occurred, making the data unreliable.

### ****Kindly Write down your answers on your Note book and than verifiy it with answers given at the end****

9- A company owner has installed a new network. Data is correct before it is transmitted across the network.

The company owner is concerned that data might have errors after transmission.

(a) Explain how the data might have errors after transmission.

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(b) The company owner decides to introduce an error detection system to check the data for errors after transmission.

The error detection system uses an odd parity check and a positive automatic repeat query (ARQ).

(i) Describe how the error detection system operates to check for errors.

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(ii) Give two other error detection methods that could be used.

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2 ......................................................................................................................................[2]

(c) The company owner also installs a firewall to help protect the network from hackers and malware.

(i) Explain how the firewall operates to help protect the network.

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(ii) Give two examples of malware that the firewall can help protect the network from.

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2 ......................................................................................................................................[2]