Assignment Activity Unit 2

Department of Computer Science, UoPeople

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Instructor Sarika Arora

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**Data Communication and Network Infrastructure Design for a Manufacturing Plant and Office Complex**

**Introduction** This report presents a comprehensive network design for a new manufacturing plant and office complex. The manufacturing environment experiences significant electromagnetic interference (EMI) due to heavy machinery, while the office requires reliable support for data-intensive tasks such as video conferencing and high-speed internet access. Additionally, the company plans to provide high-speed internet services to nearby residential and business customers, necessitating an upgraded network infrastructure. This report evaluates line coding schemes, transmission media, and multiplexing techniques to ensure an efficient and robust network.

### 1. Comparison and Analysis of Line Coding Schemes

Line coding is essential for encoding digital data into signals for reliable transmission at the physical layer. The three line coding schemes evaluated are Manchester, Differential Manchester, and Non-Return to Zero (NRZ).

#### ****Manchester Encoding****

* **Mechanism**: Incorporates clock and data signals with transitions at the middle of each bit period. A high-to-low transition represents a "0," while a low-to-high transition represents a "1."
* **Advantages**:
  + Self-synchronizing due to frequent transitions.
  + Effective in mitigating interference, as transitions help recover clock signals.
* **Disadvantages**:
  + Requires higher bandwidth compared to NRZ.
  + Less efficient for long-distance transmission.

#### ****Differential Manchester Encoding****

* **Mechanism**: Similar to Manchester encoding but represents data using transitions at the start of a bit period rather than its middle.
* **Advantages**:
  + Enhanced noise immunity compared to Manchester encoding.
  + Self-synchronizing and robust in high-interference environments.
* **Disadvantages**:
  + More complex encoding and decoding process.
  + Higher bandwidth requirements.

#### ****Non-Return to Zero (NRZ)****

* **Mechanism**: Uses high and low voltage levels to represent "1" and "0" without returning to zero between bits.
* **Advantages**:
  + Simple implementation.
  + Efficient bandwidth usage.
* **Disadvantages**:
  + Lacks self-synchronization, making it prone to clock drift.
  + Poor performance in EMI-prone environments.

#### ****Justification for the Manufacturing Plant****

Given the high EMI in the manufacturing plant, **Differential Manchester encoding** is the most suitable choice. Its robustness against noise and self-synchronization capabilities ensure reliable data transmission, making it preferable despite its higher bandwidth requirements.

### 2. Comparison of Transmission Media

Selecting the appropriate transmission media depends on bandwidth, transmission distance, susceptibility to interference, and cost. The three primary options are twisted pair, coaxial cable, and fiber-optic cable.

#### ****Twisted Pair Cable****

* **Bandwidth**: Up to 10 Gbps (Cat 6a).
* **Transmission Distance**: Up to 100 meters.
* **Susceptibility to Interference**: High, especially in EMI-heavy environments.
* **Cost**: Low.
* **Use Case**: Suitable for workstation connections in the office due to cost-effectiveness and ease of installation.

#### ****Coaxial Cable****

* **Bandwidth**: Up to 10 Gbps.
* **Transmission Distance**: Up to 500 meters.
* **Susceptibility to Interference**: Moderate, with better shielding than twisted pair cables.
* **Cost**: Moderate.
* **Use Case**: Suitable for backbone connections within the office and external service provider links.

#### ****Fiber-Optic Cable****

* **Bandwidth**: Up to 100 Tbps.
* **Transmission Distance**: Up to 40 km without repeaters.
* **Susceptibility to Interference**: Immune to EMI.
* **Cost**: High.
* **Use Case**: Ideal for backbone connections and external service provider links due to high bandwidth and immunity to EMI.

#### ****Recommended Transmission Media****

* **Workstations**: **Twisted pair cables (Cat 6a)** for affordability and sufficient bandwidth.
* **Backbone Connections**: **Fiber-optic cables** for high-speed data transfer and future scalability.
* **External Service Providers**: **Fiber-optic cables** to ensure reliable, high-speed connectivity.

### 3. Comparison of Multiplexing Techniques

Multiplexing enhances bandwidth utilization by enabling multiple signals to share a single transmission medium. The two primary techniques are Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM).

#### ****Time Division Multiplexing (TDM)****

* **Mechanism**: Divides transmission time into slots, with each signal assigned a specific slot.
* **Bandwidth Allocation**: Fixed per channel.
* **Scalability**: Limited by the number of available time slots.
* **Resistance to Interference**: Susceptible to timing issues in high-interference environments.
* **Use Case**: Best suited for predictable traffic patterns.

#### ****Frequency Division Multiplexing (FDM)****

* **Mechanism**: Divides bandwidth into frequency bands, assigning each signal a unique frequency.
* **Bandwidth Allocation**: Fixed frequency per channel.
* **Scalability**: Limited by available frequency spectrum.
* **Resistance to Interference**: More resilient in high-interference environments due to frequency separation.
* **Use Case**: Ideal for environments with diverse traffic types and high interference.

#### ****Recommended Multiplexing Technique****

For the company’s diverse customer base, **FDM** is the most effective choice. Its ability to support various traffic types while maintaining strong resistance to interference ensures optimal bandwidth utilization for both the manufacturing plant and office complex.

### ****Conclusion****

This report analyzed and justified the selection of line coding schemes, transmission media, and multiplexing techniques for the new manufacturing plant and office complex. Differential Manchester encoding is recommended due to its robustness in high-interference environments. Fiber-optic cables provide optimal performance for backbone connections and external links, while twisted pair cables are cost-effective for workstation connections. Finally, FDM is the preferred multiplexing technique for maximizing bandwidth efficiency across diverse network environments. These choices will ensure a reliable, scalable, and high-performance network infrastructure tailored to the company’s needs.

### ****References****

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