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| **Course Name:** | **MCAN Laboratory** | **Semester:** | **VI** |
| **Date of Performance:** | **26 / 01 / 2025** | **Batch No.:** | **B - 2** |
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| **Faculty Sign & Date:** |  | **Grade/Marks:** | **\_\_\_ / 25** |

**Experiment No.: 4**

**Title: Experiment on 802.11 WLAN**

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| **Aim and Objective of the Experiment:** |
| Observe and understand the effect of changing bandwidth in WLAN Wi-Fi using using the IEEE 802.11 standard. |

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| **COs to be achieved:** |
| **CO2:** Compare different types of wireless networks used in MANET. |

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| **Tools required:** |
| NetSim software |

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| **Theory:** |
| **Effect of Changing Bandwidth in WLAN Wi-Fi**  Wireless Local Area Networks (WLAN) operate using Wi-Fi technology, which transmits data over radio frequencies. One of the key factors influencing the performance of a Wi-Fi network is the **channel bandwidth**, which determines how much frequency space a signal occupies. The bandwidth can be adjusted to optimize speed, range, and interference resistance.  **Wi-Fi Bands and Channel Bandwidth**  Wi-Fi networks typically operate in the **2.4 GHz, 5 GHz, and 6 GHz** frequency bands. Each band consists of multiple channels, and the bandwidth setting determines how many channels are combined to increase data transmission capacity.   * **Standard Wi-Fi Bandwidth Options:**   + **20 MHz:** Default and most stable option, commonly used in the 2.4 GHz band.   + **40 MHz:** Offers higher speeds but may cause more interference.   + **80 MHz & 160 MHz:** Used in 5 GHz and 6 GHz bands for high-speed applications but are more susceptible to interference.   **Impact of Bandwidth on WLAN Performance**   1. **Data Transmission Speed:**    * A **higher bandwidth** (e.g., 40 MHz, 80 MHz, 160 MHz) increases data transfer rates because more data can be transmitted per second.    * A **lower bandwidth** (e.g., 20 MHz) has a lower data rate but is more reliable in congested environments. 2. **Interference and Network Congestion:**    * **Higher bandwidth** channels overlap more with adjacent channels, increasing the chance of interference.    * **Lower bandwidth** channels minimize interference and improve stability, especially in environments with multiple networks. 3. **Range and Signal Penetration:**    * **Higher bandwidth** signals degrade more over distance and struggle to penetrate walls.    * **Lower bandwidth** signals travel further and are more stable in complex environments. 4. **Device Compatibility:**    * Not all devices support higher bandwidths like 80 MHz or 160 MHz.    * Legacy devices and IoT devices often work best on 20 MHz. 5. **Use Case Considerations:**    * **20 MHz**: Best for general web browsing, IoT devices, and office environments.    * **40 MHz**: Suitable for moderate-speed applications like video calls and HD streaming.    * **80 MHz & 160 MHz**: Ideal for high-speed applications like 4K streaming and gaming but require low interference conditions.   Adjusting Wi-Fi bandwidth directly affects network performance. A higher bandwidth provides faster speeds but increases interference, while a lower bandwidth improves stability and range. The optimal bandwidth depends on the specific application, network congestion, and environmental conditions. |

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| **Implementation details:** |
| 1. **Enlist all the Steps followed and various options explored.** 2. Go to New Simulation and choose network Internetworks. 3. Choose Grid/Map settings. 4. Click and drop required devices. 5. To connect the devices, select Wired/Wireless link and click devices to connect. Wired or wireless link is automatically chosen depending on the type of device. 6. Right click on the device and choose properties. Configure the parameters as required. 7. Click Application icon and configure application type, source id, destination id and various other application parameters. 8. To enable plots click on Plots menu item and select the links and application whose throughput needs to be plotted. 9. Click on Paket Trace menu item to enable the attributes to be logged. 10. Finally, click on Run button to run simulation and set the simulation time. 11. **Explain your program logic and methods used.**   Network Setup in NetSim:   * Configure a WLAN scenario with multiple nodes (access points, clients). * Select Wi-Fi standards (802.11n/ac/ax) for simulation. * Set different bandwidth values (40 MHz, 160 MHz).   Simulation Execution:   * Run simulations for different bandwidth settings. * Measure key performance parameters (throughput, delay, packet loss).   Data Collection & Analysis   * Compare throughput vs. bandwidth. * Observe changes in latency and signal strength. |

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| **Output/ results after execution:** |
| **BW = 40MHz**              **BW = 160MHz** |

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| **Post Lab Subjective/Objective type Questions:** |
| * + 1. **Discuss hidden node and exposed node problem in 802.11.**   In wireless networks such as IEEE 802.11, the hidden node problem arises when two devices that are not within each other’s transmission range attempt to communicate with a common receiver. Since these devices cannot detect each other’s signals, they may transmit data at the same time, causing a collision at the receiver. For example, if node A and node C both want to send data to node B but A and C are outside each other's range, their simultaneous transmissions will interfere at B, resulting in a collision. This hidden node problem leads to frequent retransmissions, wastage of bandwidth, and reduced overall network performance.  On the other hand, the exposed node problem occurs when a node mistakenly refrains from transmitting even though its transmission would not cause any interference. In this case, a device senses the medium as busy because it detects another nearby transmission, but in reality, it could have transmitted to a different receiver without any issue. For instance, if node B is transmitting data to node A, node C, which is within the transmission range of B, might unnecessarily wait before sending data to another node D, even though B’s communication would not affect C’s transmission. This unnecessary deferral leads to under-utilization of the wireless channel and decreases network efficiency.   * + 1. **Explain working of WLAN with RTS and CTS mechanisms.**   To overcome the hidden node problem and reduce collisions in WLANs, IEEE 802.11 introduced the RTS/CTS (Request to Send / Clear to Send) mechanism. The working of the RTS/CTS protocol begins when a sender first sends a short RTS frame to the intended receiver, asking for permission to transmit data. This RTS frame contains the sender’s identity and the expected duration of data transmission. Upon receiving the RTS, if the receiver is ready to accept data, it responds with a CTS frame. The CTS frame not only informs the sender that it can proceed with data transmission but also alerts all nearby devices to remain silent for the specified period to avoid collision.  Once the sender receives the CTS, it proceeds with sending the actual data packet to the receiver. After successfully receiving the data, the receiver sends an acknowledgment (ACK) back to the sender. Through this handshake process, other nodes within the network are made aware of the ongoing transmission and defer their transmissions appropriately, thereby preventing hidden node collisions. The RTS/CTS mechanism is especially useful when transmitting large data packets because the overhead caused by the RTS/CTS exchange is relatively small compared to the cost of retransmitting large packets due to collisions. Hence, RTS/CTS improves the reliability and efficiency of wireless communication in WLANs. |

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| **Conclusion:** |
| The experiment provided hands-on experience with simulating a WLAN using the IEEE 802.11 standard in NetSim. It demonstrated how different factors like security protocols, interference, and network configurations affect WLAN performance. |

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| **Signature of faculty in-charge with Date:** |