**Aim 1. Analyze the provided routing table and use it to construct a network topology.**

**Router>show ip route**

**C 10.0.0.0/8 is directly connected, Serial2/0**

**C 192.168.1.0/24 is directly connected, FastEthernet0/0**

**R 192.168.2.0/24 [120/1] via 10.10.10.2, 00:00:20, Serial2/0**

**C 192.168.3.0/24 is directly connected, FastEthernet1/0**

**R 192.168.4.0/24 [120/1] via 10.10.10.2, 00:00:20, Serial2/0**

**✅ Complete Practical Steps:**

**🔸 Step 1: Open Cisco Packet Tracer**

1. Launch **Cisco Packet Tracer**.
2. Create a **new blank project**.

**🔸 Step 2: Add Devices**

Drag and drop the following devices from the bottom pane into the workspace:

* **2 Routers** (Router0 and Router1)
* **2 Switches** (Switch1 and Switch2)
* **4 PCs** (PC1, PC2, PC3, PC4)

**🔸 Step 3: Add Serial Modules to Routers**

Serial ports are not available by default, so:

1. Click **Router0** → go to **Physical tab**.
2. Turn **off the power** by clicking the power button on the left.
3. Drag the **WIC-2T module** into an empty slot on the right.
4. Turn the power **back on**.

Repeat steps 1–4 for **Router1**.

✅ This adds Serial0/0/0 ports on both routers.

**🔸 Step 4: Connect Devices**

**🟦 Router0 Connections**

1. **Router0 → Switch1 (for PC1)**
   * **Use Copper Straight-Through Cable.**
   * **Click on Router0 → select GigabitEthernet0/0.**
   * **Click on Switch1 → select any free port, e.g., FastEthernet0/1.**
2. **Router0 → Switch2 (for PC3)**
   * **Use Copper Straight-Through Cable.**
   * **Click on Router0 → select GigabitEthernet1/0.**
   * **Click on Switch2 → select any free port, e.g., FastEthernet0/1.**
3. **Router0 → Router1 (Serial Link)**
   * **Make sure you've added the WIC-2T module to both routers as described earlier.**
   * **Use Serial DCE Cable.**
   * **Click on Router0 → select Serial0/0/0.**
   * **Click on Router1 → select Serial0/0/0.**

**🟩 Router1 Connections**

1. **Router1 → PC2**
   * **Use Copper Straight-Through Cable.**
   * **Click on Router1 → select GigabitEthernet0/0.**
   * **Click on PC2 → select FastEthernet0.**
2. **Router1 → PC4**
   * **Use Copper Straight-Through Cable.**
   * **Click on Router1 → select GigabitEthernet1/0.**
   * **Click on PC4 → select FastEthernet0.**

**💻 PC to Switch Connections**

1. **PC1 → Switch1**
   * **Use Copper Straight-Through Cable.**
   * **Click on PC1 → select FastEthernet0.**
   * **Click on Switch1 → select another free port, e.g., FastEthernet0/2.**
2. **PC3 → Switch2**
   * **Use Copper Straight-Through Cable.**
   * **Click on PC3 → select FastEthernet0.**
   * **Click on Switch2 → select another free port, e.g., FastEthernet0/2.**

**🔸 Step 5: Assign IP Addresses**

| **Device/Interface** | **IP Address** | **Subnet Mask** | **Gateway** |
| --- | --- | --- | --- |
| Router0 G0/0 | 192.168.1.1 | 255.255.255.0 |  |
| Router0 G1/0 | 192.168.3.1 | 255.255.255.0 |  |
| Router0 S0/0/0 | 10.10.10.1 | 255.0.0.0 |  |
| Router1 S0/0/0 | 10.10.10.2 | 255.0.0.0 |  |
| Router1 F0/0 | 192.168.2.1 | 255.255.255.0 |  |
| Router1 F1/0 | 192.168.4.1 | 255.255.255.0 |  |
| PC1 | 192.168.1.10 | 255.255.255.0 | 192.168.1.1 |
| PC2 | 192.168.2.10 | 255.255.255.0 | 192.168.2.1 |
| PC3 | 192.168.3.10 | 255.255.255.0 | 192.168.3.1 |
| PC4 | 192.168.4.10 | 255.255.255.0 | 192.168.4.1 |

⏩ Default Gateways for PCs = Corresponding router interface IP

**🔸 Step 6: Configure Routers**

1. Click on each **router**, go to the **Config tab**, then **interfaces** (G0/0, G1/0, S0/0/0, F0/0, etc.).
2. Assign the IP addresses listed above and **set "Port Status" to ON**.
3. For the router with the **DCE end** of the serial cable (check under interface), set:
4. Clock Rate: 64000

**🔸 Step 7: Configure PCs**

Click each PC → **Desktop tab** → **IP Configuration**:

* Assign IP address and subnet mask from the table above.
* Set the **Default Gateway** as the router port IP they’re connected to.

**🔸 Step 8: Enable Routing (RIP)**

On both **Router0** and **Router1**:

1. Go to the **Config tab** → Click on **RIP (Routing Information Protocol)**.
2. **Enable RIP**.
3. Add the following networks:

**Router0:**

10.0.0.0

192.168.1.0

192.168.3.0

**Router1:**

10.0.0.0

192.168.2.0

192.168.4.0

✅ RIP will exchange route info automatically.

**🔸 Step 9: Test the Network**

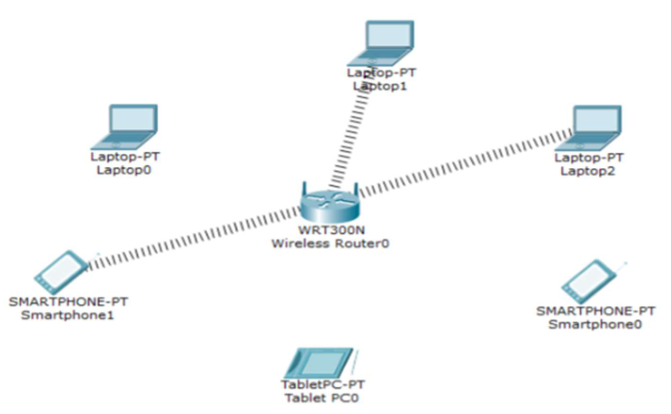
Use the **ping command** to test connectivity:

* From PC1, ping PC2, PC3, PC4.
* From PC2, ping others.
* If successful, routing is working.

📍 Ping from the **Command Prompt** inside each PC (Desktop tab → Command Prompt):

ping 192.168.2.10

**Aim 2. Create MAC protocol simulation implementation for wireless sensor Network.**

****

**✅ Step-by-Step Procedure**

**🔸 Step 1: Open Cisco Packet Tracer**

1. Launch **Cisco Packet Tracer**.
2. Create a **new blank project**.

**🔸 Step 2: Add Devices**

From the **bottom-left pane**, drag and drop the following devices:

| **Device Type** | **Quantity** | **Model** |
| --- | --- | --- |
| Wireless Router | 1 | WRT300N |
| Laptop-PT | 3 | Laptop0, 1, 2 |
| Smartphone-PT | 2 | Smartphone0, 1 |
| TabletPC-PT | 1 | TabletPC0 |

**🔸 Step 3: Set Wireless Router Configuration**

1. Click on **Wireless Router (WRT300N)**.
2. Go to **Config tab** → **Wireless0 Interface**.
3. Set the following:
   * **SSID**: WSN-MAC
   * **Channel**: 6 or default
   * **Network Mode**: Mixed
   * **Authentication**: Open (for now)
4. Ensure **Port Status** is **ON**.
5. Go to **Config tab** → **FastEthernet Port** and turn it **OFF** (not used here).
6. Assign IP address to Wireless Router:
   * Go to **Config > Wireless0**
   * **IP Address**: 192.168.0.1
   * **Subnet Mask**: 255.255.255.0

**🔸 Step 4: Configure Wireless Settings for Devices**

Now connect **all wireless devices** (Laptops, Smartphones, Tablets) to the same Wi-Fi network (WSN-MAC):

For each device:

**Example: For Laptop0**

1. Click on **Laptop0** → Go to **Config tab**.
2. Choose **Wireless0 Interface**.
3. Set the following:
   * **SSID**: WSN-MAC
   * **DHCP or Static IP**: Choose one:
     + **Static IP**:
       - IP: 192.168.0.2
       - Subnet: 255.255.255.0
       - Gateway: 192.168.0.1
     + OR Use **DHCP** if router DHCP is enabled.

Repeat this for:

* **Laptop1** → 192.168.0.3
* **Laptop2** → 192.168.0.4
* **Smartphone0** → 192.168.0.5
* **Smartphone1** → 192.168.0.6
* **TabletPC0** → 192.168.0.7

**🔸 Step 5: Simulate MAC Communication (CSMA/CA Simulation)**

**MAC Protocol** used in wireless communication (like Wi-Fi) in Cisco Packet Tracer is based on **CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance)**.

To simulate this:

1. Click on **Simulation Mode** (bottom right corner).
2. From the right pane, **Add a PDU** (Simple PDU tool):
   * Click **TabletPC0** → Click **Smartphone1** to send a packet.
   * Then Click **Laptop0** → Click **Laptop2**.
3. Observe the **event list** and **animation**:
   * Watch how devices **wait for channel to be free**, then **send packets**.
   * This shows **MAC behavior** in wireless communication (CSMA/CA).
4. Add more traffic (different PDUs) to **increase collision chances** and observe how devices wait.

**🔸 Step 6: Optional – Configure DHCP (Automatic IP Assignment)**

If you want to use **DHCP instead of static IPs**:

1. Go to **Wireless Router → Config → DHCP**.
2. Enable DHCP:
   * Starting IP Address: 192.168.0.2
   * Subnet Mask: 255.255.255.0
   * Default Gateway: 192.168.0.1
3. In devices, set **Wireless0 Interface → IP Configuration → DHCP**

**🔸 Step 7: Test Connectivity**

1. Go to each device → **Desktop tab → Command Prompt**.
2. Try pinging the router and other devices:
3. ping 192.168.0.1 (router)
4. ping 192.168.0.3 (another laptop)
5. ping 192.168.0.6 (smartphone)

✅ Successful pings indicate the **MAC protocol simulation is working** correctly.

**Aim 3. Create and simulate a simple adhoc network with 10 nodes, which can send and receive data.**

**✅ Detailed Step-by-Step Procedure**

**🔸 Step 1: Open Cisco Packet Tracer**

1. Launch **Cisco Packet Tracer**.
2. Create a **new blank workspace**.

**🔸 Step 2: Add Wireless Devices**

From the **“End Devices” section** (bottom-left menu), drag and drop:

| **Device Type** | **Quantity** | **Notes** |
| --- | --- | --- |
| Laptop-PT | 10 | Named Laptop0 to Laptop9 |

You can also mix in TabletPC or Smartphone if you want.

**🔸 Step 3: Set Wireless Interfaces to Ad Hoc Mode**

For each laptop (e.g., Laptop0 to Laptop9), repeat these steps:

1. Click on **Laptop0**.
2. Go to the **Config tab** → **Wireless0** (NOT Ethernet).
3. Set:
   * **SSID**: ADHOC-NET
   * **Mode**: Ad hoc (very important!)
   * **Channel**: same for all (e.g., Channel 6)
   * **Port Status**: ON
4. Set **IP Address** (choose Static IP):
   * **IP Address**: 192.168.1.1 (increment by 1 for each node)
   * **Subnet Mask**: 255.255.255.0
   * **Default Gateway**: leave blank (no router in ad hoc)

Repeat this for:

* Laptop1 → 192.168.1.2
* Laptop2 → 192.168.1.3
* ...
* Laptop9 → 192.168.1.10

**🔸 Step 4: Arrange Devices Close Together**

* Since this is a wireless ad hoc network, place devices **close together** on the screen so they are within wireless transmission range (range is limited in Packet Tracer).
* Do **not** add any router or switch.

**🔸 Step 5: Test Communication Between Nodes**

You will now **simulate sending and receiving data** between nodes.

**Option 1: Ping Test**

1. Click on **Laptop0** → Go to **Desktop tab** → **Command Prompt**.
2. Type:
3. ping 192.168.1.2
4. ping 192.168.1.3
5. ping 192.168.1.5
6. Do this from several nodes to test communication in both directions.

**Option 2: Simulation Mode**

1. Switch to **Simulation Mode** (bottom-right corner).
2. Use **Add Simple PDU Tool** (envelope icon):
   * Click on **Laptop1**, then click on **Laptop4** to send data.
   * Click on **Laptop6**, then **Laptop9**.
3. Observe the animation to see packets traveling wirelessly.
4. The simulation shows **wireless MAC behavior**, **data sending and receiving**, and **acknowledgment**.

**🔸 Step 6: Optional - File Sharing Simulation**

To simulate higher-layer communication:

1. Set up a simple **HTTP Server** on one laptop:
   * Click on **Laptop5** → Go to **Config > Services > HTTP** → Turn it ON.
2. On **Laptop2**, open **Web Browser** and type:
3. http://192.168.1.6
4. If the webpage opens, it confirms that **data is being sent and received properly**.

**Aim 4. Create a basic MANET implementation simulation for 15 mobile nodes for Packet animation and Packet Trace.**

**✅ Step-by-Step Guide in Cisco Packet Tracer**

**🔸 Step 1: Open Cisco Packet Tracer**

* Launch Cisco Packet Tracer.
* Create a new project (File > New).

**🔸 Step 2: Add 15 Wireless Mobile Nodes**

From **End Devices** section:

1. Drag and drop **15 Laptop-PT** devices into the workspace.
   * Name them **Laptop0 to Laptop14**.
   * These laptops support **wireless interfaces** and can be mobile.
2. Arrange them **in a circle or grid**, spaced closely enough for wireless range.

**🔸 Step 3: Configure Each Laptop for Wireless Ad Hoc Mode**

Do this for **each Laptop** (Laptop0 to Laptop14):

1. Click on the laptop.
2. Go to **Config** tab → Select **Wireless0**.
3. Set:
   * **SSID**: MANET-NET
   * **Mode**: Ad hoc
   * **Channel**: 6 (same for all)
   * **Port Status**: On
4. Set **Static IP Address**:
   * Use the format: 192.168.10.X (e.g., Laptop0 = 192.168.10.1, Laptop1 = 192.168.10.2, etc.)
   * Subnet Mask: 255.255.255.0
   * Default Gateway: Leave blank (no router)

🔁 Repeat for all 15 laptops.

**🔸 Step 4: Test Connectivity (Optional but Recommended)**

From any laptop:

1. Go to **Desktop > Command Prompt**.
2. Ping any other device:
3. ping 192.168.10.5
4. ping 192.168.10.10

✅ If you get a reply, the ad hoc connection is successful.

**🔸 Step 5: Switch to Simulation Mode for Packet Animation**

1. Switch from **Realtime** to **Simulation Mode** (bottom-right).
2. Use the **Add Simple PDU Tool (Envelope Icon)**:
   * Click on **Laptop0**, then click on **Laptop5**.
   * This creates a **simple data transfer packet**.
3. Click **Play** to see the packet animation.
   * You’ll see the packet traveling from one laptop to another using wireless links.

**🔸 Step 6: Enable Mobility (Optional)**

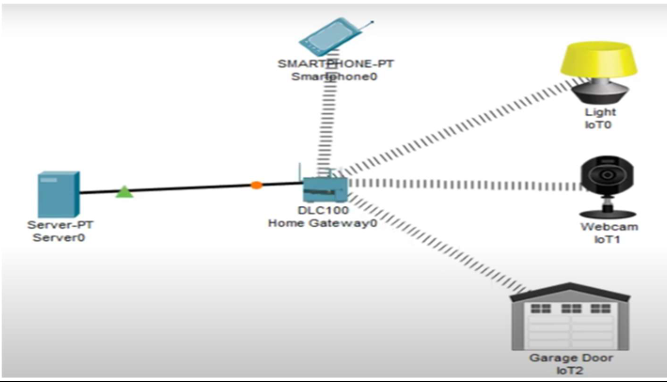
Cisco Packet Tracer allows **manual movement** of devices:

1. Use the **Move Tool (Arrow with Cross)** from the toolbar.
2. Move a few laptops (e.g., Laptop6, Laptop7) while the simulation is running.
   * This simulates **mobile behavior**.

**🔸 Step 7: Use Event List for Packet Trace**

1. In Simulation Mode, click on **Event List** (bottom).
2. Select any packet and click **"PDU Information"**.
3. View **packet details**, such as:
   * Source/Destination IP
   * Packet type
   * Transmission medium (Wireless)
   * MAC layer info (for MAC-level tracing)

**Aim 5. Simulate Directional Antenna with the help of a home automation system using the following.**



**✅ Step-by-Step Guide in Cisco Packet Tracer**

**🔸 Step 1: Open Cisco Packet Tracer & Start a New Project**

* Launch Cisco Packet Tracer.
* Go to **File > New**.

**🔸 Step 2: Add Devices as per the Diagram**

From the **IoT Components** and **End Devices** section:

| **Device Type** | **Name in PT** | **Quantity** |
| --- | --- | --- |
| Home Gateway | DLC100 | 1 |
| IoT Light | Light | 1 |
| IoT Webcam | Webcam | 1 |
| IoT Garage Door | Garage Door | 1 |
| Smartphone | Smartphone-PT | 1 |
| Server | Server-PT | 1 |

**🔸 Step 3: Place & Connect Devices**

1. **Place all devices** on the workspace similar to the given diagram.
2. Connect the **Server to the Home Gateway (DLC100)** using a **Copper Straight-Through** cable.
3. All **IoT devices** (Light, Webcam, Garage Door) and **Smartphone** connect **wirelessly** to the **Home Gateway**.

**🔸 Step 4: Configure the Server**

1. Click on **Server0**.
2. Go to **Config > Settings**.
3. Turn **HTTP** and **IoT Services** to **ON**.

**🔸 Step 5: Configure the Home Gateway (DLC100)**

1. Click on **DLC100 (Home Gateway)**.
2. Go to **Config > Wireless0**:
   * **SSID**: HomeNet
   * **Channel**: 6
   * **Mode**: Infrastructure
   * Turn **Port Status** to ON.
3. Assign IP to Home Gateway:
   * **IP Address**: 192.168.0.1
   * **Subnet Mask**: 255.255.255.0

**🔸 Step 6: Configure IoT Devices**

For each device (Light, Webcam, Garage Door):

1. Click the device.
2. Go to **Config > Settings**:
   * Set **Display Name** as IoT0, IoT1, IoT2 respectively.
3. Go to **Wireless** tab:
   * **SSID**: HomeNet
   * Enable **DHCP** to get IP from Home Gateway.

**🔸 Step 7: Configure Smartphone**

1. Click **Smartphone0**.
2. Go to **Config > Wireless** tab:
   * **SSID**: HomeNet
   * Use **DHCP**.

**🔸 Step 8: Configure Directional Antenna**

Now simulate **Directional Antennas**:

1. Click on **Home Gateway (DLC100)**.
2. Go to **Physical Tab** (Power off device first).
3. Change the **antenna type** of the **wireless module** to **Directional Antenna**.
   * Do the same for **IoT devices** if needed.
4. Power back ON the Home Gateway.

📌 This simulates focused signal transmission in specific directions rather than all around (omnidirectional).

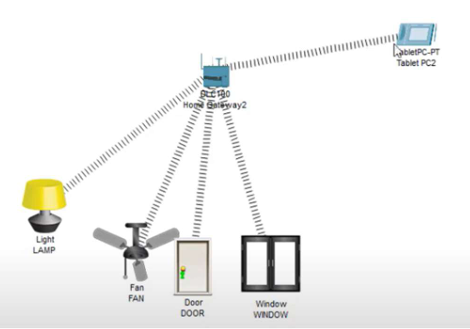
**🔸 Step 9: Test Communication**

1. Go to **Smartphone > Desktop > Web Browser**.
2. Enter IP of Home Gateway: 192.168.0.1.
3. Access and control **IoT devices** via browser interface.
4. You can **toggle the light**, **open the garage**, or **view the webcam**.

**🔸 Step 10: Simulation Mode (Optional)**

1. Switch to **Simulation Mode** (bottom right).
2. Add **Simple PDU** from Smartphone to IoT device.
3. Watch how packets are routed via the **directional antenna**.

**Aim 6. Simulate Directional Antenna with the help of a home automation system using the following.**



**⚙️ Step-by-Step Configuration in Cisco Packet Tracer**

**🔸 Step 1: Start a New Project**

* Open **Cisco Packet Tracer**.
* Go to **File > New**.

**🔸 Step 2: Place Devices**

From the **IoT Components** & **End Devices** section:

* Drag and drop:
  + 1x DLC100 Home Gateway
  + 1x IoT Light
  + 1x IoT Fan
  + 1x IoT Door
  + 1x IoT Window
  + 1x TabletPC-PT

Arrange them as per the diagram.

**🔸 Step 3: Configure Home Gateway (DLC100)**

1. Click on DLC100.
2. Go to **Config > Wireless0**:
   * **SSID**: SmartHome
   * Turn **Port Status: ON**
   * **Mode**: Infrastructure
   * **Channel**: 6 (default)
3. Go to **Config > Settings**:
   * **Display Name**: Home Gateway
4. Assign static IP if required:
   * **IP Address**: 192.168.0.1
   * **Subnet Mask**: 255.255.255.0

**🔸 Step 4: Configure IoT Devices (Light, Fan, Door, Window)**

For **each device**, do the following:

1. Click on the device.
2. Go to **Config > Settings**:
   * Set names as LAMP, FAN, DOOR, WINDOW.
3. Go to **Wireless tab**:
   * **SSID**: SmartHome
   * Enable **DHCP** (so IP is auto-assigned)
   * **Authentication**: Open

**🔸 Step 5: Configure the Tablet (TabletPC-PT)**

1. Click on **TabletPC-PT**.
2. Go to **Config > Wireless**:
   * Connect to SSID: SmartHome
   * Mode: DHCP
3. It will get IP from the Home Gateway.

**🔸 Step 6: Set Directional Antennas**

To simulate **directional antenna**:

1. Click on **Home Gateway**.
2. Go to the **Physical tab**.
3. Power off the device (click the power button).
4. Locate the wireless antenna module.
5. Change the **Antenna Type** from **Omnidirectional** to **Directional**.
6. Power it back **ON**.

You can optionally set directional antennas on IoT devices as well.

**🔸 Step 7: Test Control from Tablet**

1. Click **TabletPC-PT** > **Desktop > Web Browser**.
2. Enter IP of Home Gateway: 192.168.0.1.
3. You should see options to control:
   * LAMP (Light)
   * FAN
   * DOOR
   * WINDOW
4. Toggle each device ON/OFF.

**🔸 Step 8: Use Simulation Mode (Optional)**

To see **how packets flow** via directional antenna:

1. Switch to **Simulation Mode** (bottom-right corner).
2. Use **Add Simple PDU** tool:
   * Click on Tablet.
   * Then click on LAMP, FAN, etc.
3. Click **Play** to watch packet flow (in a directed path).

**Aim 7. Simulate Mobile Adhoc Network with Directional Antenna using a suitable simulator software.**

**⚙️ Step-by-Step Procedure in Cisco Packet Tracer**

**🔸 Step 1: Open Cisco Packet Tracer**

* Start a **new project**: File > New.

**🔸 Step 2: Add Mobile Nodes (Laptops/Smartphones)**

* Drag 4–6 **Laptop-PT** or **Smartphone-PT** devices from the **End Devices** section.
* Arrange them in a circular or scattered pattern to simulate mobility.

**🔸 Step 3: Configure Wireless Interfaces**

**For each Laptop/Smartphone**:

1. Click on the device.
2. Go to **Config > Wireless0**.
3. Set:
   * **SSID**: MANET
   * **Mode**: Ad hoc
   * **Channel**: Same for all (e.g., Channel 6)
   * **Authentication**: Open
   * **IP Address (Manual)**: Give static IPs like:
     + 192.168.1.1 → Laptop1
     + 192.168.1.2 → Laptop2
     + 192.168.1.3 → Laptop3
     + … up to how many nodes you add.
   * **Subnet Mask**: 255.255.255.0

✅ Make sure all nodes use the same **SSID** and **channel**.

**🔸 Step 4: Set Directional Antennas**

For each device:

1. Click the **device** > **Physical tab**.
2. Turn **OFF the power** (press red power button).
3. Locate the **wireless antenna module** (next to the interface card).
4. Click to change the **Antenna Type** from *Omnidirectional* to *Directional*.
5. Turn the power **ON** again.

You can reposition the antenna to **point towards a specific device** (optional visual step).

**🔸 Step 5: Test Connectivity**

1. Click on any device (say Laptop1).
2. Go to **Desktop > Command Prompt**.
3. Type:
4. ping 192.168.1.2
   * You should get replies if devices are within range and correctly configured.

Repeat pings between other devices.

**🔸 Step 6: Simulate Packet Transfer**

1. Switch to **Simulation Mode** (bottom-right corner).
2. Click on **Add Simple PDU Tool** (lightning bolt icon).
3. Click on **Laptop1** → then click on **Laptop2**.
4. Click **Play** to observe how packets are routed.
   * You’ll see how packets go **directionally** between nodes.

**🔸 Step 7: Simulate Mobility (Optional)**

* Move devices slightly apart or closer.
* Observe how **connectivity is affected** (some devices will disconnect when out of range).

**Aim 8. Define the following terms: a. Sensor Node, b. Base Station, c. Graphic User Interface, d. Sink Node**

**a. Sensor Node:**  
A sensor node is a small, low-power device embedded with sensors to collect data from its environment. It is typically part of a wireless sensor network (WSN), where it measures physical parameters like temperature, humidity, motion, etc., and transmits the data to a base station or sink node for further processing or analysis.

**b. Base Station:**  
A base station is a central node in a network that communicates with sensor nodes and often acts as a data aggregation point. It collects data transmitted by the sensor nodes, processes the information, and may relay it to a central system for analysis or decision-making. In wireless sensor networks, the base station typically has more computational power and energy resources compared to the sensor nodes.

**c. Graphic User Interface (GUI):**  
A Graphic User Interface (GUI) is a type of user interface that allows users to interact with software applications or hardware systems through graphical icons, buttons, menus, and other visual elements, rather than text-based commands. GUIs make it easier for users to interact with complex systems, especially for those who are not familiar with programming or command-line interfaces.

**d. Sink Node:**  
A sink node is a type of node in a wireless sensor network that serves as the endpoint for the data collected from other sensor nodes. It aggregates, stores, and forwards the data to a base station or a central processing unit. Sink nodes are responsible for the data collection and can be seen as a central point where all the data from the sensor nodes converge.

**Aim 9. Create a mobile network busing Cell Tower, Central Office Server, Web Browser and Web Server. Simulate connection between them.**

**1. Open Cisco Packet Tracer**

Launch Cisco Packet Tracer and start with a **New Workspace**.

**2. Add Required Devices**

From the device categories at the bottom:

* **Wireless Devices**
  + Drag and drop **Cell Tower** to the workspace.
* **End Devices**
  + Add a **Smartphone-PT** or **Tablet-PC** (any mobile device to simulate a mobile user with a web browser).
* **Servers**
  + Add **Central Office Server** (can be simulated using a **Generic Server-PT**).
  + Add a **Web Server** (another **Generic Server**, with HTTP enabled).
* **Wired Devices (optional)**
  + Add **Switch (2960)** if you want to connect servers together.

**3. Connect the Devices**

**🔌 Use Appropriate Connections:**

* **Cell Tower to Central Office Server**:
  + Use **Copper Straight-Through Cable** if they have Ethernet ports.
  + If no port appears, it is logical connection (see step 5).
* **Central Office Server to Web Server**:
  + Connect using **Copper Straight-Through Cable**.
* **Mobile Device to Cell Tower**:
  + This is **wireless**, no cable needed. It should automatically connect (check signal range).

**4. Configure IP Addresses**

Click on each device and go to the **Desktop > IP Configuration**:

**Example IP Setup:**

| **Device** | **IP Address** | **Subnet Mask** | **Default Gateway** |
| --- | --- | --- | --- |
| Smartphone-PT | 192.168.1.10 | 255.255.255.0 | 192.168.1.1 |
| Cell Tower (Gateway) | 192.168.1.1 | 255.255.255.0 | — |
| Central Office Server | 192.168.2.1 | 255.255.255.0 | — |
| Web Server | 192.168.2.2 | 255.255.255.0 | 192.168.2.1 |

Enable **IP routing** on the Central Office Server if acting as a router.

**5. Set Up Wireless Communication**

* Click on the **Cell Tower**
  + Ensure it supports wireless signals and is within range of the smartphone/tablet.
* Configure **SSID (e.g., “MobileNet”)** on Cell Tower.
  + Go to **Physical > Wireless Settings** or **Config > Wireless Interface**.
* On **Smartphone or Tablet**, go to **Desktop > PC Wireless**, connect to **MobileNet** SSID.

**6. Configure Web Server**

Click on **Web Server > Services**:

* Enable **HTTP**.
* Optionally edit **index.html** in the HTTP service to customize webpage.

**7. Test the Simulation**

**From Smartphone:**

* Go to **Desktop > Web Browser**
* Type the IP address of the Web Server (e.g., 192.168.2.2)
* If everything is set up correctly, the webpage should load.

**8. Simulate Data Flow (Packet Animation)**

* Go to **Simulation Mode** (bottom-right).
* Click **Add Simple PDU** (envelope icon).
* Click **Smartphone**, then click **Web Server**.
* Press **Play** to see how packets flow through Cell Tower → Central Office → Web Server.

**Aim 10. Design a simulation for a basic Mobile Ad-hoc Network (MANET) implementation, incorporating packet animation and packet trace functionalities. The network should comprise 12 nodes, with mobility management facilitated by appropriate devices.**

**🛠️ Step-by-Step Instructions**

**🔹 Step 1: Open Cisco Packet Tracer**

* Launch Cisco Packet Tracer.
* Click **File > New Project** to start a new workspace.

**🔹 Step 2: Add Wireless Nodes**

You need **12 mobile devices**:

* From the **End Devices** section, choose **Laptop-PT** or **Smartphone-PT**.
* Drag and drop **12 laptops** or smartphones onto the workspace.

These will act as your **mobile nodes** in the MANET.

**🔹 Step 3: Add a Wireless Router or Access Point**

Although MANETs are **infrastructure-less**, Packet Tracer needs an **Access Point or Wireless Router** as a central point to facilitate communication for simulation purposes.

* Go to **Wireless Devices**
* Drag and drop **Wireless Router (e.g., Linksys)** or **Access Point** into the workspace.

**🔹 Step 4: Connect Devices to Wireless Network**

* Click on each laptop or smartphone.
* Go to **Desktop > PC Wireless > Connect**
* Select the SSID (like **“MANET-Network”**) created by your Wireless Router.
* Click **Connect**.

Do this for all 12 devices.

**🔹 Step 5: Assign IP Addresses (Automatically)**

* Go to **Config > Settings** on the **Wireless Router**.
* Enable **DHCP**.
* Set starting IP address to something like 192.168.0.100.
* All 12 nodes will receive IPs dynamically.

To verify:

* On each device, go to **Desktop > IP Configuration**, and confirm IP is assigned.

**🔹 Step 6: Simulate Mobility**

* Select **Move Tool** (arrow with cross icon from top toolbar).
* Drag and **manually move** laptops around the workspace to simulate **mobility**.
* You can move them during simulation (this mimics node mobility).

❗ Cisco Packet Tracer does **not support automated mobility**, so movement is done manually.

**🔹 Step 7: Enable Packet Animation (Simulation Mode)**

* Switch to **Simulation Mode** (click the **Simulation tab** at bottom right).
* Select **Add Simple PDU** (envelope icon).
* Click on one Laptop (source), then another Laptop (destination).
* The simulation will auto-create a packet.

Click **Play** to observe the packet traveling wirelessly.

**🔹 Step 8: Observe Packet Trace**

* Click the **packet** in the event list.
* See how the packet is sent via wireless channel from source to destination.
* You’ll see data encapsulation, MAC layer interaction, etc.

Repeat between different nodes to see how the network handles communication.

**✅ Final Output:**

* All 12 nodes are connected wirelessly.
* You simulate communication (like sending pings).
* You trace packet movement from node to node.
* You demonstrate **node mobility** by manually moving nodes during the simulation.

**Aim 11. Write a short note on the nesC model and nesC Component.**

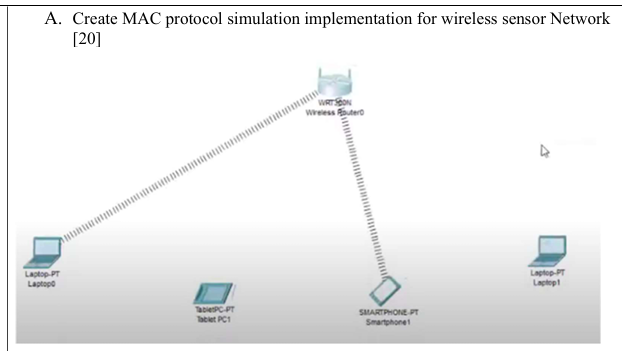
**🔸 nesC Model**

* The **nesC model** is **component-based** and **event-driven**.
* Programs are built from **components** that **interact via interfaces**.
* Supports **concurrency** and **asynchronous events** (e.g., sensor data arrival).
* Focuses on **low-power, embedded network devices**.
* Strongly emphasizes **compile-time linking**, improving performance and reliability.

**🔸 nesC Component**

* A **component** in nesC is the **basic building block**.
* There are two types of components:
  1. **Modules** – Contain the actual implementation (code).
  2. **Configurations** – Connect different components (wiring).
* Components use **interfaces** to communicate:
  1. **Provides** interfaces (services it offers).
  2. **Uses** interfaces (services it needs).
* Components are **statically linked**, meaning their connections are fixed at compile time.

**Aim 12.**

****

**🛠️ Steps to Perform in Cisco Packet Tracer**

**🔹 Step 1: Setup the Devices**

1. **Open Cisco Packet Tracer.**
2. From the bottom-left corner, **select "End Devices"** and drag and drop the following:
   * 2x **Laptop-PT** (Laptop0, Laptop1)
   * 1x **Tablet-PC-PT** (Tablet PC1)
   * 1x **Smartphone-PT** (Smartphone1)
3. From **"Wireless Devices"**, drag:
   * **1x Wireless Router (e.g., WRT300N or WRT50N)**

**🔹 Step 2: Configure Wireless Router**

1. Click on the **Wireless Router (WRT50N)**.
2. Go to **"Config"** tab → **Wireless**:
   * SSID: WSN-MAC
   * Channel: 6 (default)
   * Enable **DHCP** (optional, to auto-assign IP)
3. **Set Security**:
   * Enable **WPA2-PSK**
   * Set password: wsn12345

**🔹 Step 3: Connect Wireless Devices**

1. Click on each device (Laptop, Smartphone, Tablet):
   * Go to **Config** → **Wireless0**
   * Set SSID: WSN-MAC
   * Authentication: WPA2-PSK
   * Passphrase: wsn12345
   * Set to **DHCP** or assign static IP (if DHCP is off)
2. Wait till all devices are **connected wirelessly** to the router.

**🔹 Step 4: Check Network Connectivity**

1. Open **Laptop0**, click **Desktop > Command Prompt**
   * Type: ping 192.168.0.x (other device IP)
   * Successful ping means MAC layer and network layer communication is active.

**🔹 Step 5: Observe MAC Layer Functionality**

1. Click on **Simulation Mode** (from bottom-right corner).
2. Set **Filter** to show only **ARP and ICMP**.
3. Generate a ping from **Laptop0 → Smartphone1**.
4. Click **Capture/Forward** to watch:
   * **ARP Request/Reply**
   * **ICMP Echo Request/Reply**

These ARP packets and their interaction show **MAC-level communication**, which is the basis for MAC protocol simulation in WSN.

**Aim 13.**

**Read and Analyze the Routing table: [20]**

**C 168.150.10.0/24 directly connected serial0/0**

**C 168.150.11.0/24 directly connected fa0/0**

**C 168.150.12.0/24 directly connected serial0/1**

**R 168.150.13.0/24 (120/2) via 168.150.10.1 serial0/0**

**R 168.150.14.0/24 (120/1) via 168.150.10.1 serial0/0**

**R 168.150.15.0/24 (120/1) via 168.150.12.1 serial 0/1**

Sure! Let's go through **Aim 13** step-by-step.

**🧪 Aim 13: Read and Analyze the Routing Table**

**Objective**: To understand how to interpret a routing table and verify routes in a network using **Cisco Packet Tracer**.

**✅ What You Need:**

* Cisco Packet Tracer
* 2-3 Routers (e.g., 3x 2811 Routers)
* PCs (optional for ping testing)
* Serial and Ethernet connections
* Basic IP configurations and RIP routing protocol enabled

**🛠️ Step-by-Step Guide in Cisco Packet Tracer**

**🔹 Step 1: Setup the Topology**

1. Open **Cisco Packet Tracer**.
2. Add **3 Routers** (e.g., Router0, Router1, Router2).
3. Add **Serial connections**:
   * Connect Serial0/0 of Router0 ↔ Serial0/0 of Router1
   * Connect Serial0/1 of Router0 ↔ Serial0/1 of Router2
4. Add **PCs (optional)** to each router’s FastEthernet0/0 if needed for testing.

**🔹 Step 2: Assign IP Addresses**

On **Router0**:

interface serial0/0

ip address 168.150.10.2 255.255.255.0

no shutdown

interface serial0/1

ip address 168.150.12.2 255.255.255.0

no shutdown

interface fastethernet0/0

ip address 168.150.11.1 255.255.255.0

no shutdown

On **Router1**:

interface serial0/0

ip address 168.150.10.1 255.255.255.0

no shutdown

interface fastethernet0/0

ip address 168.150.13.1 255.255.255.0

no shutdown

On **Router2**:

interface serial0/1

ip address 168.150.12.1 255.255.255.0

no shutdown

interface fastethernet0/0

ip address 168.150.15.1 255.255.255.0

no shutdown

**🔹 Step 3: Configure RIP (Routing Information Protocol)**

On **all 3 routers**:

router rip

version 2

network 168.150.0.0

no auto-summary

This enables dynamic routing so that routers exchange routes.

**🔹 Step 4: View Routing Table**

Go to **Router0**:

1. Click the router.
2. Go to **CLI tab**.
3. Type:

show ip route

You’ll see something like:

C 168.150.10.0/24 is directly connected, Serial0/0

C 168.150.11.0/24 is directly connected, FastEthernet0/0

C 168.150.12.0/24 is directly connected, Serial0/1

R 168.150.13.0/24 [120/2] via 168.150.10.1, Serial0/0

R 168.150.14.0/24 [120/1] via 168.150.10.1, Serial0/0

R 168.150.15.0/24 [120/1] via 168.150.12.1, Serial0/1

**📊 Analyze the Routing Table**

| **Code** | **Meaning** |
| --- | --- |
| C | Connected directly to the router |
| R | Learned via RIP (Routing protocol) |

* **C 168.150.10.0/24**: Direct connection on Serial0/0
* **R 168.150.13.0/24 (120/2)**: Learned via RIP, 120 = RIP default AD (Administrative Distance), 2 = hop count
* **R 168.150.15.0/24**: Reached via Serial0/1 through Router2

**🔹 Step 5: Verify Routing**

From Router0’s CLI:

ping 168.150.13.1

ping 168.150.15.1

Both should reply if routing is working properly.

**Aim 14. Create and simulate a simple adhoc network with 8 nodes, which can send and receive data.**

**🔁 Step-by-Step Simulation in Cisco Packet Tracer**

**🔹 Step 1: Open Cisco Packet Tracer**

Launch the program and start with a **new blank project**.

**🔹 Step 2: Add 8 Wireless Devices**

1. From the **End Devices** section, drag **8 Laptop-PT** or **Smartphone-PT** or a mix of wireless devices into the workspace.

**🔹 Step 3: Configure Wireless Settings (Set to Ad-Hoc)**

You must manually set each device to **Ad-hoc mode**.

**For each device:**

1. Click on the device → Go to the **Desktop tab**.
2. Open **PC Wireless** → Click on **Connect** tab.
3. Choose **Ad-hoc** from the **Mode** dropdown.
4. Set **SSID**: e.g., MyAdhocNet
5. Set **Channel**: e.g., 6 (same on all)
6. Set **Authentication** to **Open** (no password needed)
7. Click **Connect**

Repeat this for **all 8 devices**, keeping the **SSID and channel the same** on each one.

**🔹 Step 4: Assign IP Addresses (Manual)**

Since there's no DHCP, use **static IPs**.

**Go to each device → Desktop → IP Configuration:**

| **Device** | **IP Address** | **Subnet Mask** |
| --- | --- | --- |
| PC0 | 192.168.1.1 | 255.255.255.0 |
| PC1 | 192.168.1.2 | 255.255.255.0 |
| PC2 | 192.168.1.3 | 255.255.255.0 |
| PC3 | 192.168.1.4 | 255.255.255.0 |
| PC4 | 192.168.1.5 | 255.255.255.0 |
| PC5 | 192.168.1.6 | 255.255.255.0 |
| PC6 | 192.168.1.7 | 255.255.255.0 |
| PC7 | 192.168.1.8 | 255.255.255.0 |

Leave **default gateway blank** since there's no router.

**🔹 Step 5: Test Communication (Ping Test)**

1. Click on **PC0** → Desktop → Command Prompt.
2. Type:
3. ping 192.168.1.2
4. You should receive replies if connected properly.

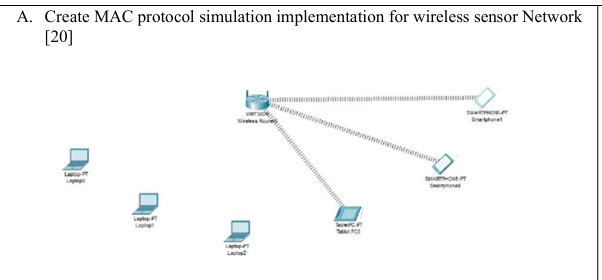
Repeat to ping from other devices to check **peer-to-peer** connectivity.

**🔹 Step 6: Packet Simulation (Optional)**

To **see packet flow**:

1. Switch to **Simulation Mode** (bottom right).
2. Choose **Simple PDU Tool (envelope icon)**.
3. Click on **source device**, then **destination device**.
4. Click **Play** to watch packets move.

**Aim 15.**

****

**🔁 Step-by-Step Implementation**

**🔹 Step 1: Launch Cisco Packet Tracer**

* Open a new workspace.

**🔹 Step 2: Add the Wireless Router**

* From **Network Devices > Wireless Devices**, drag and drop **WRT300N Wireless Router** to the workspace.

**🔹 Step 3: Add Wireless End Devices**

* From **End Devices**, drag and place:
  + 3 **Laptop-PT**
  + 2 **Smartphone-PT**
  + 1 **Tablet PC-PT**

You should now have 6 end devices.

**🔹 Step 4: Connect Devices to Router (Wi-Fi)**

Each device must be configured to connect to the router wirelessly.

**For each device:**

1. Click the device (e.g., Laptop0) → Go to **Desktop** tab → Open **PC Wireless**.
2. Click **Connect** tab → You’ll see available wireless networks.
3. Select the SSID (e.g., HomeNetwork) of the wireless router.
4. Click **Connect**.

Do this for **all devices**.

**🔹 Step 5: Configure Wireless Router**

1. Click the router → Go to **GUI tab**.
2. Under **Wireless**, set:
   * **SSID**: SensorNet
   * **Channel**: Default or change (e.g., 6)
   * **Security Mode**: Disable or set to None for simplicity.
3. Save settings.

**🔹 Step 6: Assign IP Addresses (Automatically via DHCP)**

The router will act as a **DHCP server** to assign IP addresses to connected devices.

To confirm:

* Go to **any device** → Desktop → **IP Configuration**
* You should see an IP like 192.168.0.X, assigned by the router.

**🔹 Step 7: Test MAC Protocol Concept using Packet Simulation**

Now simulate **packet transmission** to show how the MAC layer works (data transfer coordination).

1. Switch to **Simulation Mode** (bottom right corner).
2. Select **Simple PDU (envelope icon)**.
3. Click on a **source device** (e.g., Laptop0).
4. Click on a **destination device** (e.g., Smartphone1).
5. You’ll see a packet created.
6. Click **Play (▶️)** to observe packet flow.

This shows how the **MAC layer** handles data transmission between nodes via the router.

**Aim 16. Create and simulate a simple adhoc network for 30 nodes.**

**🔁 Step-by-Step Guide to Create Adhoc Network**

**🔹 Step 1: Open Cisco Packet Tracer**

**🔹 Step 2: Add 30 Wireless-Capable Devices**

1. From **End Devices**, drag and drop **Laptop-PT** (or **Tablet PC**) into the workspace.
2. Place a total of **30 devices**.

**🔹 Step 3: Enable Wireless Interface (Wi-Fi Adaptor)**

For **each device**:

1. Click on the device (e.g., Laptop0).
2. Go to **Physical** tab.
3. Turn off the device (power button).
4. Remove **Wired Ethernet module** if present.
5. Drag and insert a **Wireless NIC (WPC300N)** into the slot.
6. Turn the power back on.

Repeat this for all 30 devices.

**🔹 Step 4: Set All Devices to Adhoc Mode**

1. Click on the device → Go to **Desktop** tab → Open **PC Wireless**.
2. Click **Connect** tab.
3. Click **Create** to set up a new wireless connection.
4. Fill:
   * **SSID**: AdhocNet
   * **Mode**: Set to Adhoc
   * **Channel**: Any same channel (e.g., 6)
   * **Security**: None (for simplicity)
5. Save and connect.

Repeat this setup for all 30 nodes. Make sure they all use **SSID = AdhocNet** and are in **Adhoc Mode**.

**🔹 Step 5: Assign IP Addresses Manually**

Since there's **no DHCP (no router)**, assign IPs manually.

**For each device:**

1. Go to **Desktop > IP Configuration**
2. Set:
   * **IP Address**: 192.168.1.X (X = 1 to 30)
   * **Subnet Mask**: 255.255.255.0
   * Leave gateway empty (no router)

Example:

* Laptop0: 192.168.1.1
* Laptop1: 192.168.1.2
* ...
* Laptop29: 192.168.1.30

**🔹 Step 6: Test Communication Between Nodes**

Now, we test that devices can **send/receive packets** in Adhoc mode.

**📦 Method 1: Using Simple PDU**

1. Switch to **Simulation Mode**.
2. Use the **envelope icon** (Simple PDU).
3. Click on **Laptop0**, then on **Laptop10**.
4. Click **Play ▶️** to view the packet delivery.

**📶 Method 2: Using Ping**

1. Go to **Laptop0 > Desktop > Command Prompt**.
2. Type: ping 192.168.1.10
3. You should see replies, confirming successful communication.

**Aim 17. Describe the concepts Events, Commands and Task of TinyOS.**

Sure! Here's a concise explanation for **Aim 17**:

**Aim 17: Describe the Concepts of Events, Commands, and Tasks in TinyOS**

**1. Events:**

* Events in TinyOS are **asynchronous** and are triggered by hardware or other components.
* Used to handle **interrupts** or **external activities** like sensor input or message reception.
* Example: An event is triggered when a packet is received.

**2. Commands:**

* Commands are **synchronous calls** to perform specific operations.
* They are invoked by **higher-level components** to request services from **lower-level components**.
* Example: A component may issue a command to turn on a sensor.

**3. Tasks:**

* Tasks are **non-preemptive**, **deferred computations** used to perform lengthy operations.
* Scheduled by components and executed after events.
* Help separate **time-consuming** processes from **time-critical** events.

**Aim 18. Create a basic MANET implementation simulation for 20 mobile nodes for Packet animation and Packet Trace.**

**Step 1: Set Up Cisco Packet Tracer**

1. **Open Cisco Packet Tracer** and create a new project (File > New).

**Step 2: Add 20 Mobile Nodes**

1. **Drag 20 mobile devices (laptops)** from the device panel:
   * Go to the **End Devices** section in the bottom-left corner.
   * Drag the **Laptop** (Generic Node) 20 times to the workspace.

**Step 3: Configure Wireless Network**

1. **Enable wireless on each node**:
   * Click on each laptop.
   * Go to the **Physical** tab and turn on the **Wireless Adapter** for each laptop.
2. **Set the same SSID and Channel**:
   * Go to the **Config** tab.
   * Set **SSID** (e.g., "MANET") and choose **Channel 1** for all nodes.
3. **Assign IP addresses**:
   * Still in the **Config** tab, assign IP addresses to each node, e.g., 192.168.0.1 to 192.168.0.20 for simplicity.

**Step 4: Enable Communication**

1. **Test connectivity**:
   * Click **Desktop > Command Prompt** on each node.
   * Use the ping command to test communication, e.g., ping 192.168.0.2.

**Step 5: Enable Packet Animation and Trace**

1. **Switch to Simulation mode**:
   * Click **Simulation** mode in the top-right corner.
2. **Start packet animation**:
   * Click on **Simulation Panel** to see packet traces (source, destination, path).

**Step 6: Run and Observe**

1. **Start the simulation** by clicking **Play**.
2. **Watch packets move** between nodes in the animation, tracking the path and routing behavior.

**Step 7: Save the Project**

1. **Save your work**: Click **File > Save As** to store the simulation.