Mobile Ad-hoc and Wireless Sensor Networks

Lesson 02

Mobile Ad-hoc Network (MANET) Properties and Spectrum needs at the nodes

MANET Properties

- Seamless interaction and ubiquitous mobile computing environment
- Seamless connectivity maintained between the devices when they move with the nearby wireless nodes, sensor nodes, and embedded devices in automobiles

MANET Properties

- Neighbour discovery— One of the important characteristics of a MANET node
- Data routing abilities — data can be routed from a source node to a neighbouring node

MANET Properties

- Flexible network architecture and variable routing paths — to provide communication in case of the limited wireless connectivity range and resource constraints

MANET Properties

- Flexibility— enables fast establishment of networks
- When a new network is to be established, the only requirement is to provide a new set of nodes with limited wireless communication range
- A node has limited capability, that is, it can connect only to the nodes which are nearby and thus consumes limited power

MANET Properties

- Using a service discovery protocol, a node discovers the service of a nearby node and communicates to a remote node in the MANET
- Peer-to-Peer connectivity

MANET Properties

- Decentralization of Computations — independent computational, switching (or routing), and communication capabilities

MANET Properties

- Limited wireless connectivity range—require that a node should move in the vicinity of at least one nearby node within the wireless communication range, else the node should be provided with the access-point of wired communication

MANET Properties

- Weak connectivity and remote server latency
- Unreliable links to base station or gateway — failure of an intermediate node results in greater latency in communicating with the remote server

MANET PROPERTIES

- Resource constraints– Limited bandwidth available between two intermediate nodes
- Node may have limited power and thus computations need to be energy-efficient

MANET PROPERTIES

- No need of access-point
- Only selected access-points provided for connection to other networks or other MANETs

MANET PROPERTIES

- Need to solve exposed or hidden terminal problem
- Diversity in nodes— iPods, palm handheld computers, Smartphones, PCs, smart labels, smart sensors, and automobile-embedded systems

MANET PROPERTIES

- Protocol diversity— Nodes can use different protocols, for example, IrDA, Bluetooth, ZigBee, 802.11, GSM, or TCP/IP
- Data caching, saving, and aggregation at node

Bandwidth FIXED infrastructure network

- An access-point-based network
- Large number devices connects to a centralized server
- The bandwidth requirement too high

Bandwidth FIXED infrastructure network

- N devices using FDMA in duplex transmission, then the required bandwidth will be $2 \times N \times f_{bw0}$, where f_{bw0} is the bandwidth allotted to one device for sending a packet to its access-point

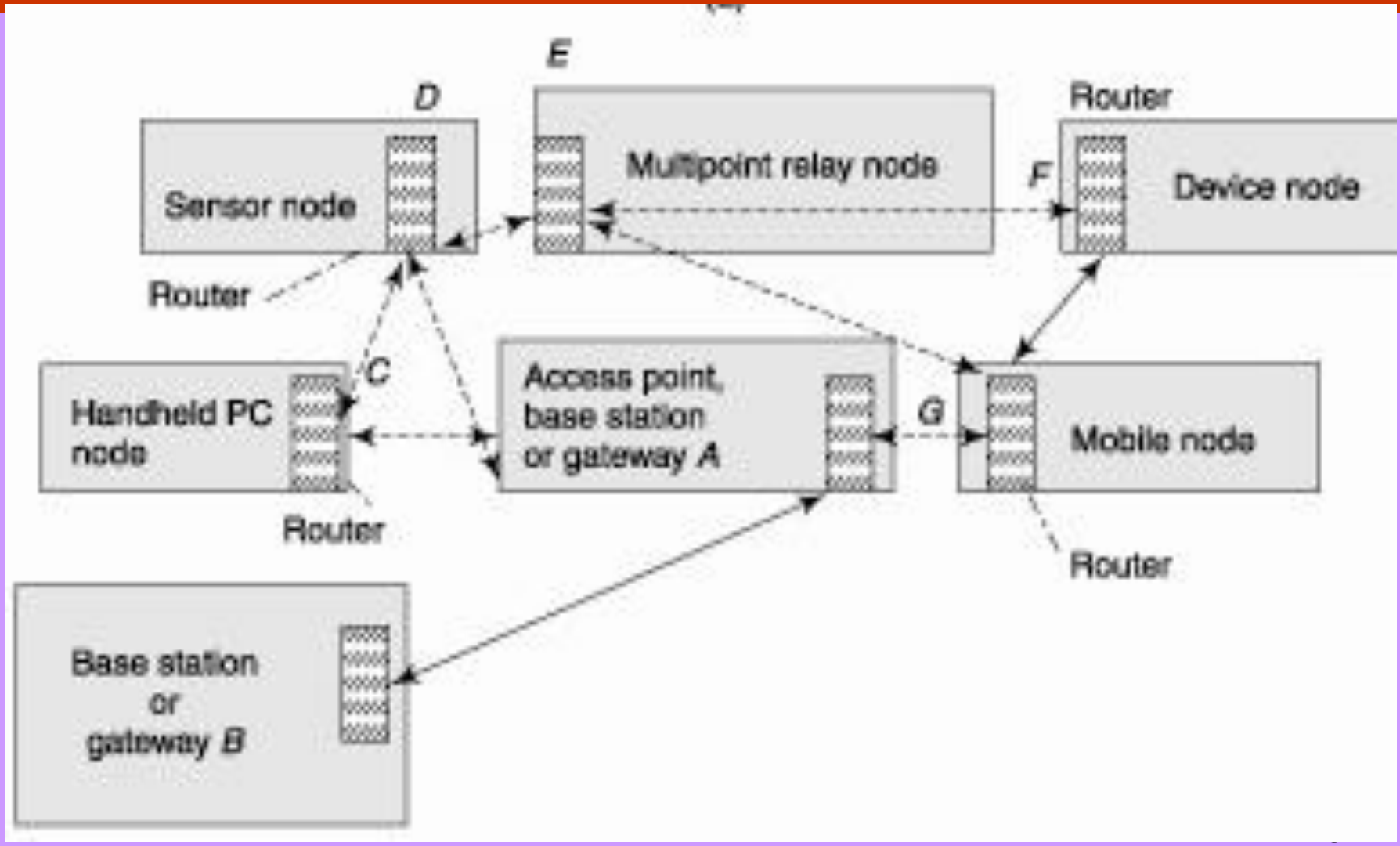
Bandwidth fixed infrastructure network

- **Access-point** using TDMA and SDMA communication, the bandwidth (spectrum) requirement is reduced

Spectrum requirement at Nodes in MANET

- Each MANET node has much smaller frequency spectrum requirements than that for a node in a fixed infrastructure network

Mobile ad-hoc network (MANET) Nodes A to G



Spectrum requirement at Nodes in MANET

- A node itself — a router for all the packets coming from or going to the other nodes
- Node *D* at a given instant— Can get incoming packets from *E*, *F*, *G*, and *A* and can send packets to *C* and *A* or vice versa

Spectrum requirement at Nodes in MANET

- Nodes are themselves mobile
- Therefore, bandwidth available to any node at any instant is variable
- MANET enables spectrum reuse

Spectrum requirement at Nodes in MANET

- Each wireless link provides a limited bandwidth
- MANET communication is multi-hop
- When node *D* transmits to *G*, it is through the three hops—(i) *D*—*E*, (ii) *E*—*F*, and (iii) *F*—*G*.

Each node has low and adaptable transmission power

- Optimized to have signal strength just sufficient to carry the signal up to single hop
- Hops can therefore occur simultaneously using the same frequency band

Each node has low and adaptable transmission power

- There is spatial reuse of bandwidth
- Also, the bandwidth depends on surrounding environment

Bandwidth Need computations

- Assume FDMA mode access by a node
- The bandwidth depends on the number of next hop neighbours
- The node with higher number of next hop neighbours require higher bandwidth in FDMA
- The nodes *D*, *E*, and *G* shall need higher bandwidth compared to *C* and *F*

Bandwidth Need computations

- Bandwidth required will be $2 \times 3 \times f_{bw0}$ when three nodes *D*, *E*, or *G* can transmit in full duplex mode to all the nodes
- Will be $2 \times 2 \times f_{bw0}$ for two nodes *C* or *F*
- When each node path and each direction hop scheduled to operate at different instants, as in TDMA, then the bandwidth required will be just f_{bw0}

Summary

- Node's Neighbour discovery in MANET
- Data routing abilities
- Flexible network architecture
- Variable routing paths to provide communication
- Limited wireless connectivity range and resource constraints

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- Protocol diversity
- Nodes diversity
- Weak connectivity
- Limited spectrum requirements
- Multi-hop transmission

End of Lesson 02

Mobile Ad-hoc Network (MANET) Properties and Spectrum needs at the nodes