

CONNECTED DOMINATING SETS AS BACKBONES

Need Backbone

- Some topology control schemes aim at selecting certain nodes from the network to create a backbone that can be used in several ways.
- A backbone is connected if the network of solely backbone nodes remains connected (after selecting them from the originally connected network). Some backbone structures are used to improve the efficiency of data communication protocols.

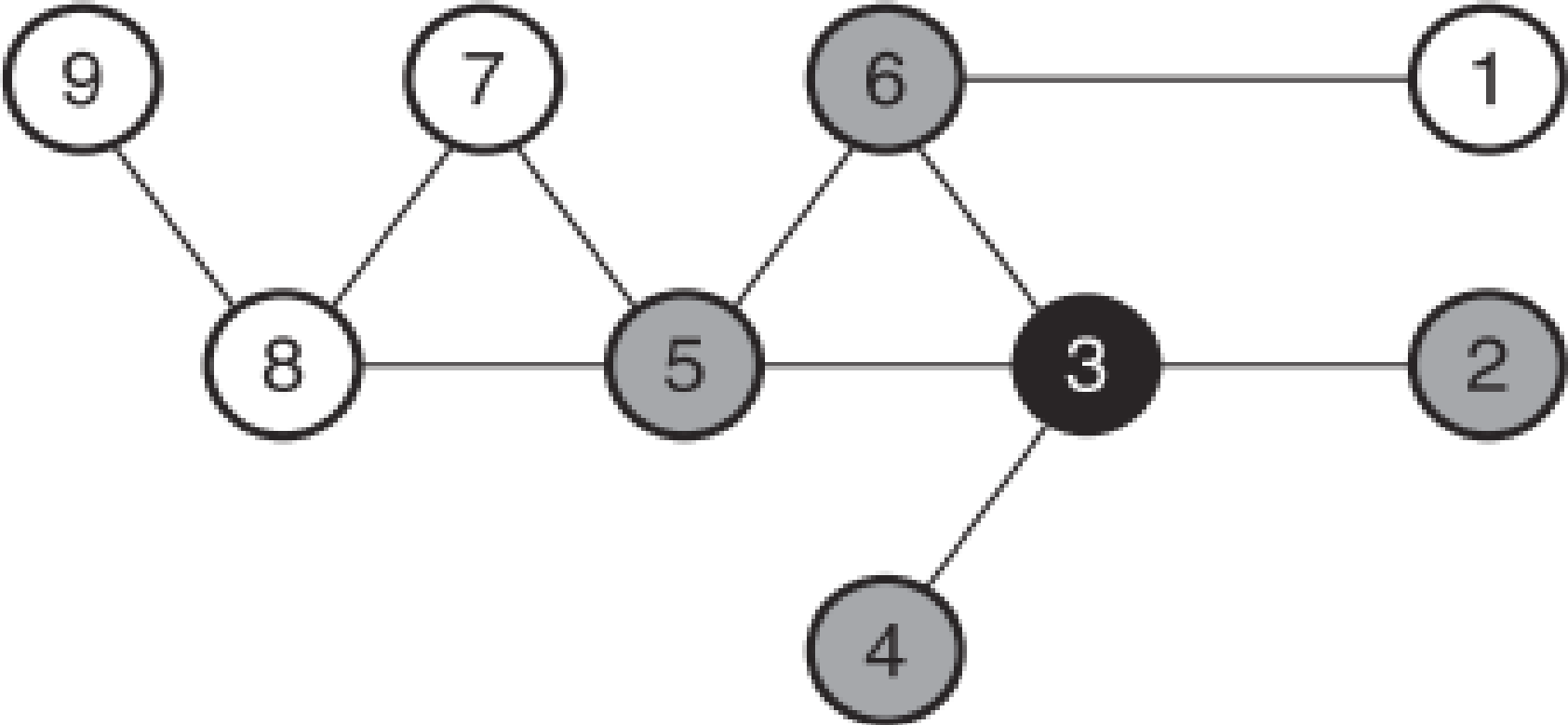
CONNECTED DOMINATING SETS AS BACKBONES

- Connected dominating sets are one of the primary techniques used to build backbones for wireless sensor and ad hoc networks.
- The nodes in CDS are called dominators, while other nodes are called dominatees.

Centralized Set Cover-Based Algorithms

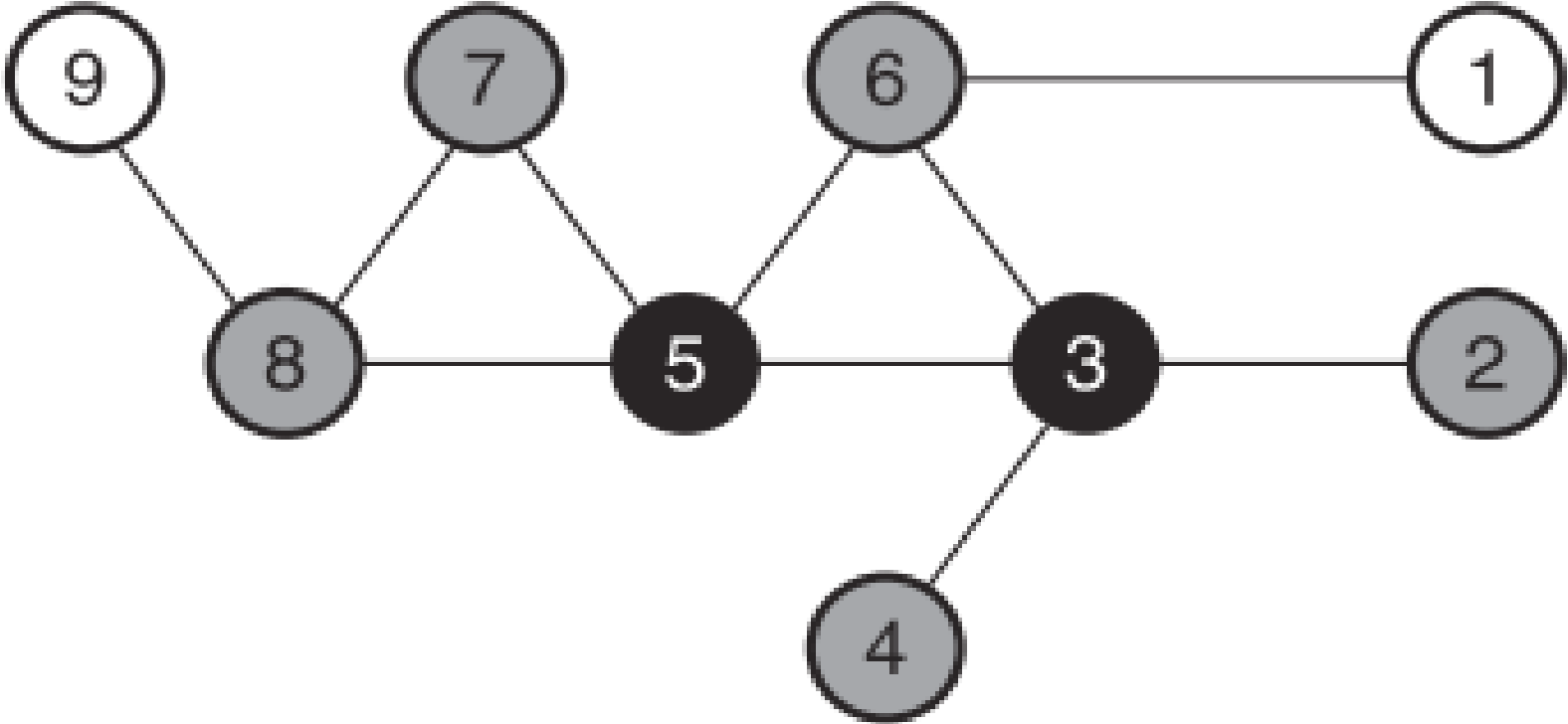
- Guha and Khuller (1998) proposed centralized algorithms to build a CDS for general graphs.
- The first each node is initially colored white.
- Next, the node with the largest degree is colored black and all its neighbors are colored gray.
- This last step is repeated until there are no white nodes left in the graph.
- Each time, the gray node with the largest number of white neighbors is colored black and then all its white neighbors are colored gray.
- Node IDs can be used to break ties. Finally,
- all black nodes form a CDS.

CDS Formation



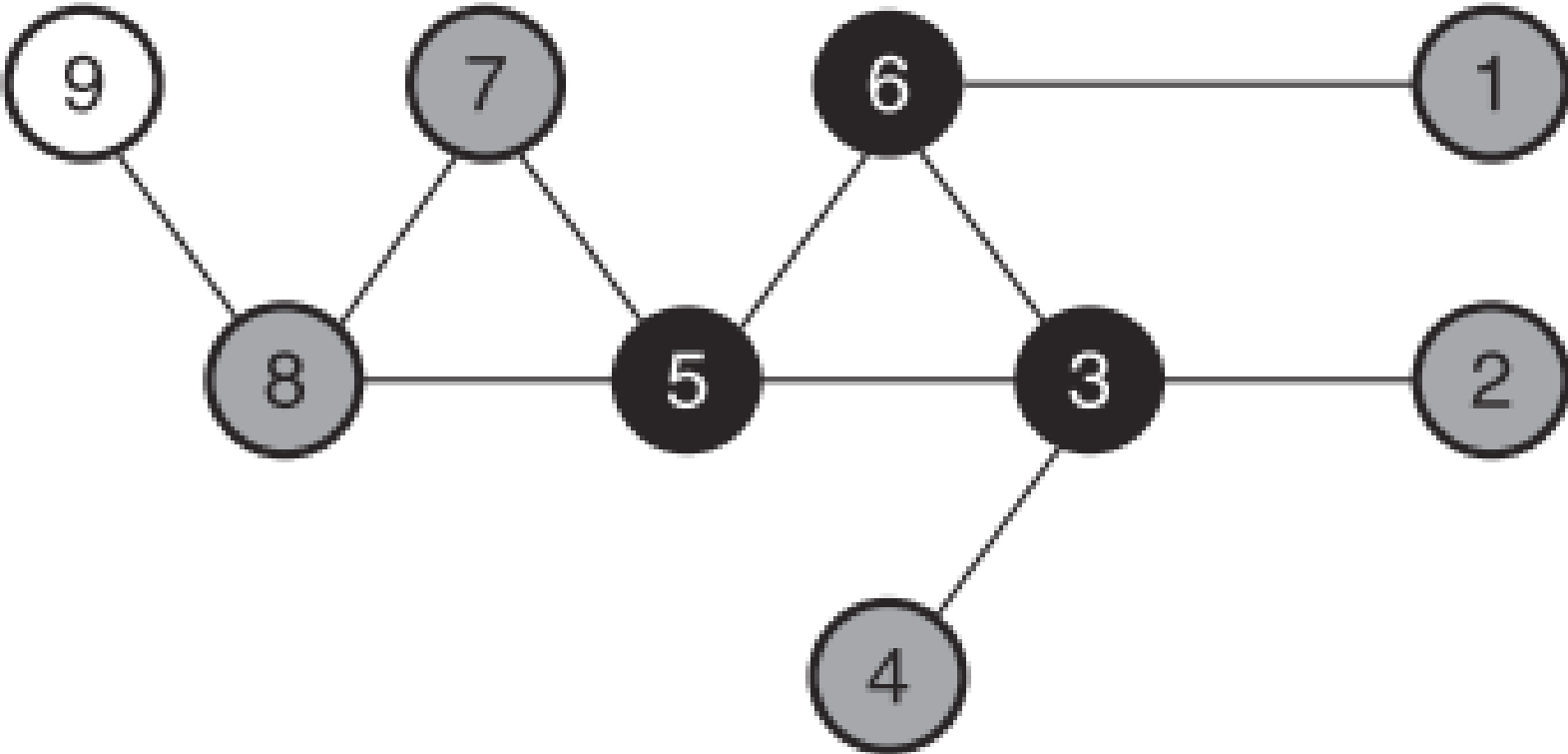
Step 1

CDS Formation



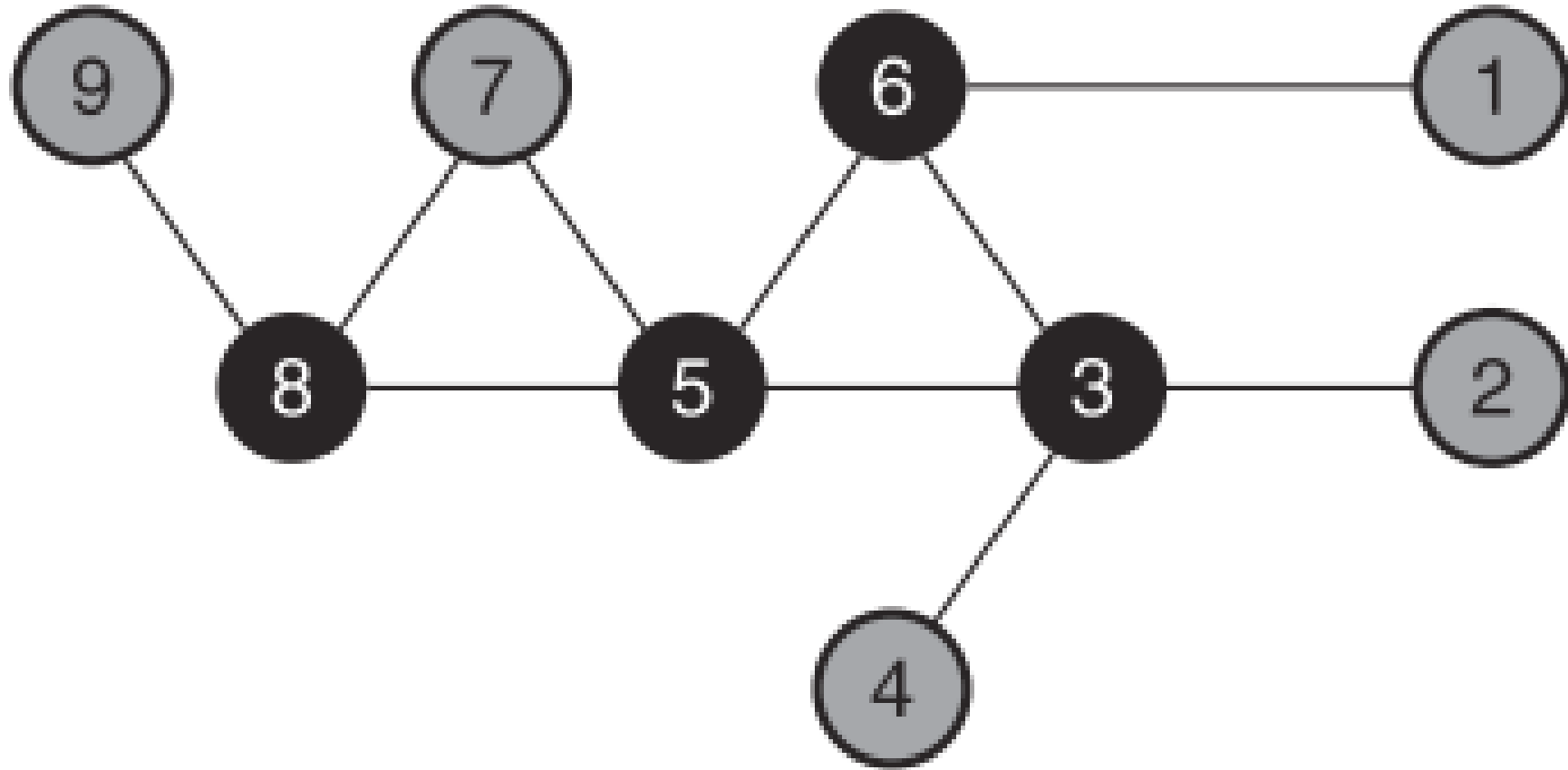
Step 2

CDS Formation



Step 3

CDS Formation



Step 4

MIS

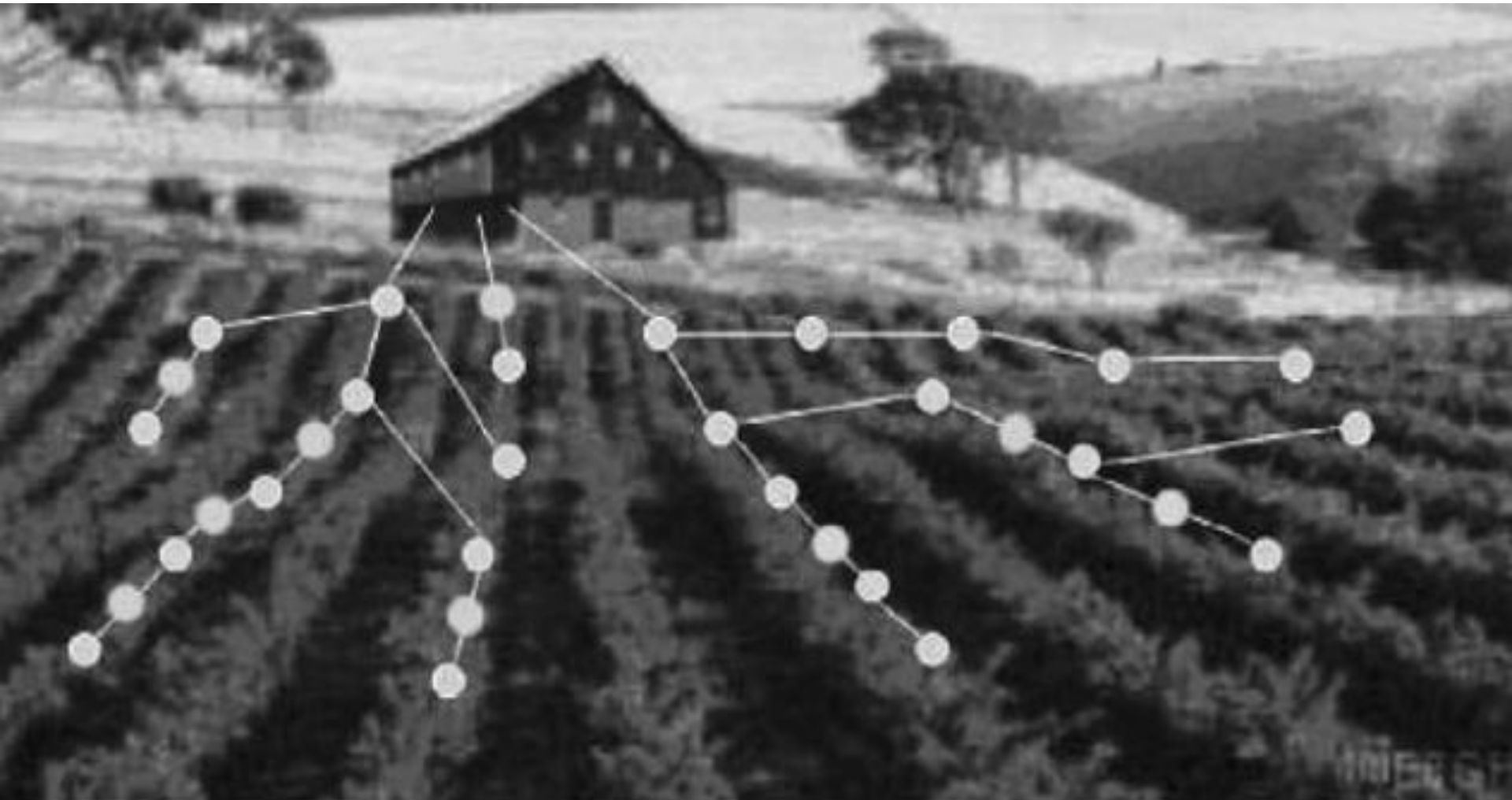
- A MIS is an independent set which is not a subset of any other independent set. The largest
- MIS is called the maximum independent set
- Backbone construction algorithms are normally applied to unit disk graph (UDG) where all nodes are assumed to have a common transmission range.

- The maximal independent set (MIS) is an important concept which is used in
- the construction of some clustering and CDS-based backbones. An independent
- set is a set of vertices in a graph where no two vertices are adjacent.

MIS-Based CDS

- Alzoubi provide two versions of an algorithm to construct the dominating set for a wireless network.
- The basic idea of the algorithms in this category is to compute and then connect an MIS.
- In both algorithms, they first employ the distributed leader election algorithm to construct a rooted spanning tree from the original network topology.

- In data gathering or aggregation, data from each sensor is forwarded to the sink along the spanning tree.



- The labelling process begins from the root node and finishes at the leaves.
- The node with the lowest rank marks itself black and broadcasts a DOMINATOR message
- The rank of a node is the ordered pair of its level (number of hops to the root of the spanning tree) and its ID.

- The marking process then continues according to the following rules:
 1. If the first message that a node receives is a DOMINATOR message, it marks itself gray and broadcasts a DOMINATEE message.
- 2. If a node received DOMINATEE messages from all its lower rank neighbors, it marks itself black and sends a dominator message.

- The marking process finishes when it reaches the leaf nodes. At that time
- The set of black nodes form an MIS

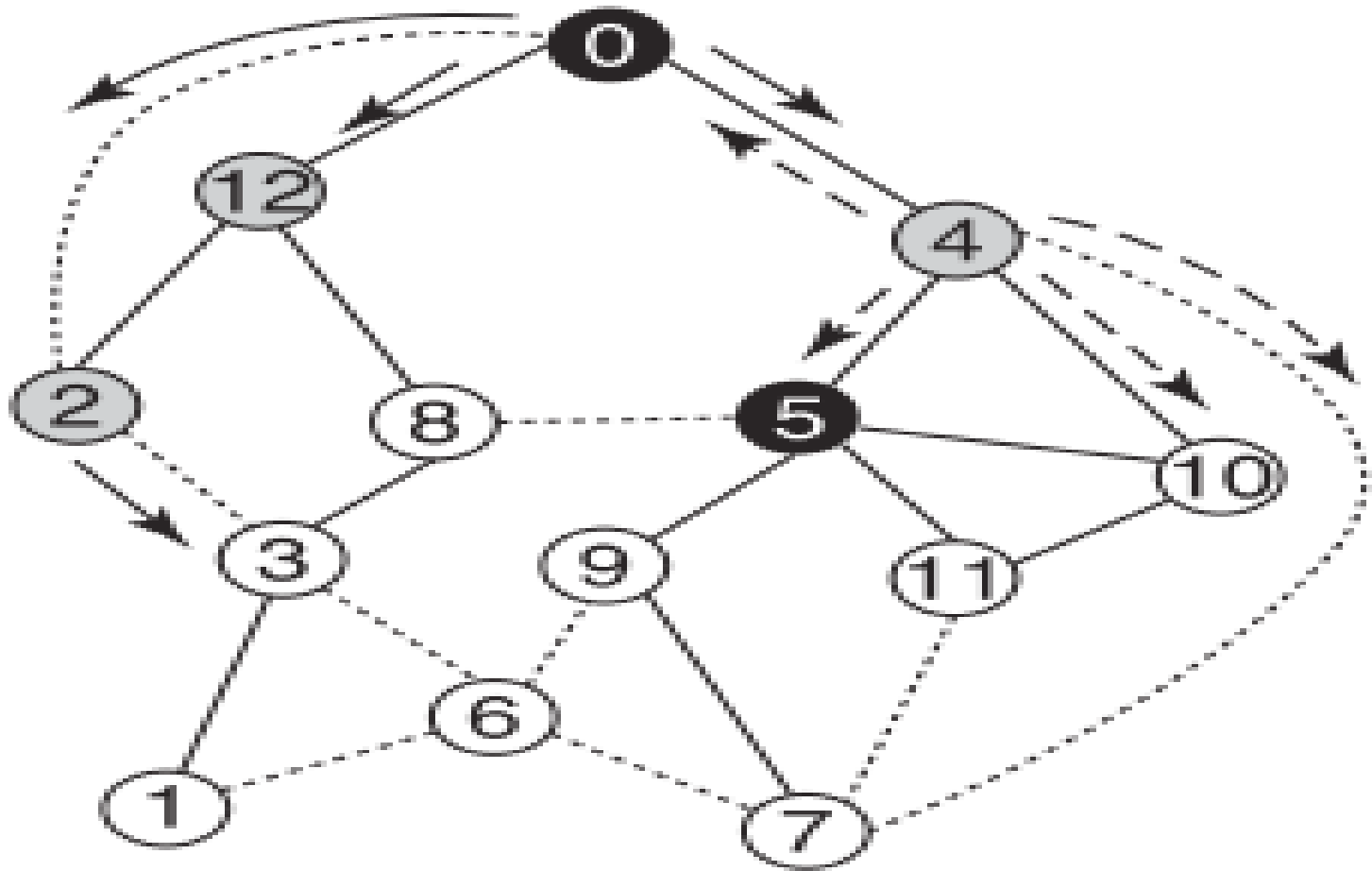
Formation of CDs

- The final phase connects the nodes in the MIS to form a CDS, using INVITE and JOIN messages.
- Initially, the root joins the CDS and broadcasts an INVITE message. The INVITE message is relayed to all two-hop neighbors out of the current CDS.
- When a black node receives the INVITE message for the first time, it joins the dominating tree together with the gray node, which relayed the message.
- It then initiates an INVITE message. The process terminates when all the black nodes join the CDS.

GRAPH-MIS Based

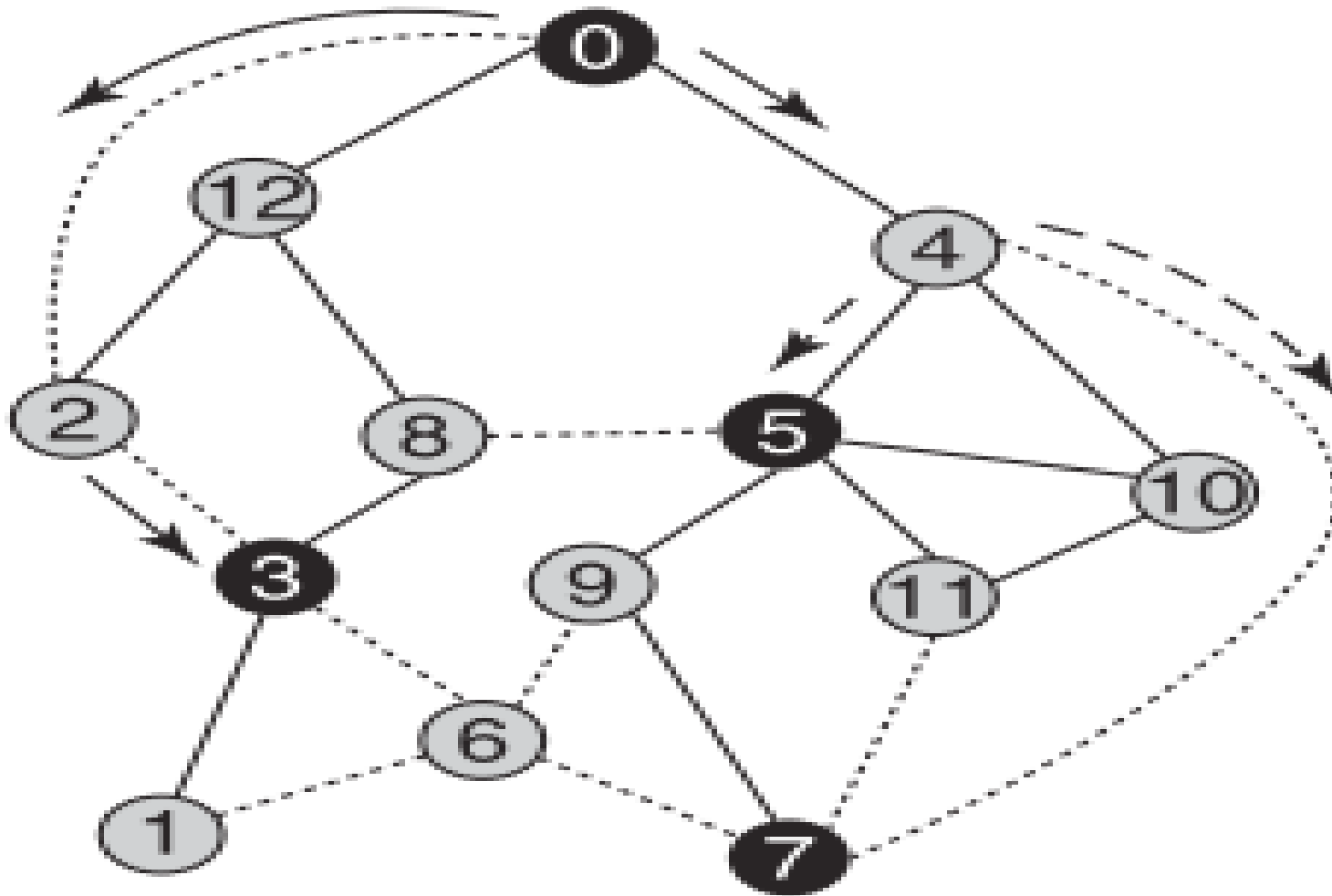
- In this graph, node 0 is the root of the spanning tree that is constructed by using the leader election algorithm.
- The solid lines represent the edges of the rooted spanning tree, and the dashed lines represent other edges in the UDG. Node 0 is marked black first and broadcasts a DOMINATOR message

MIS Based Algorithm



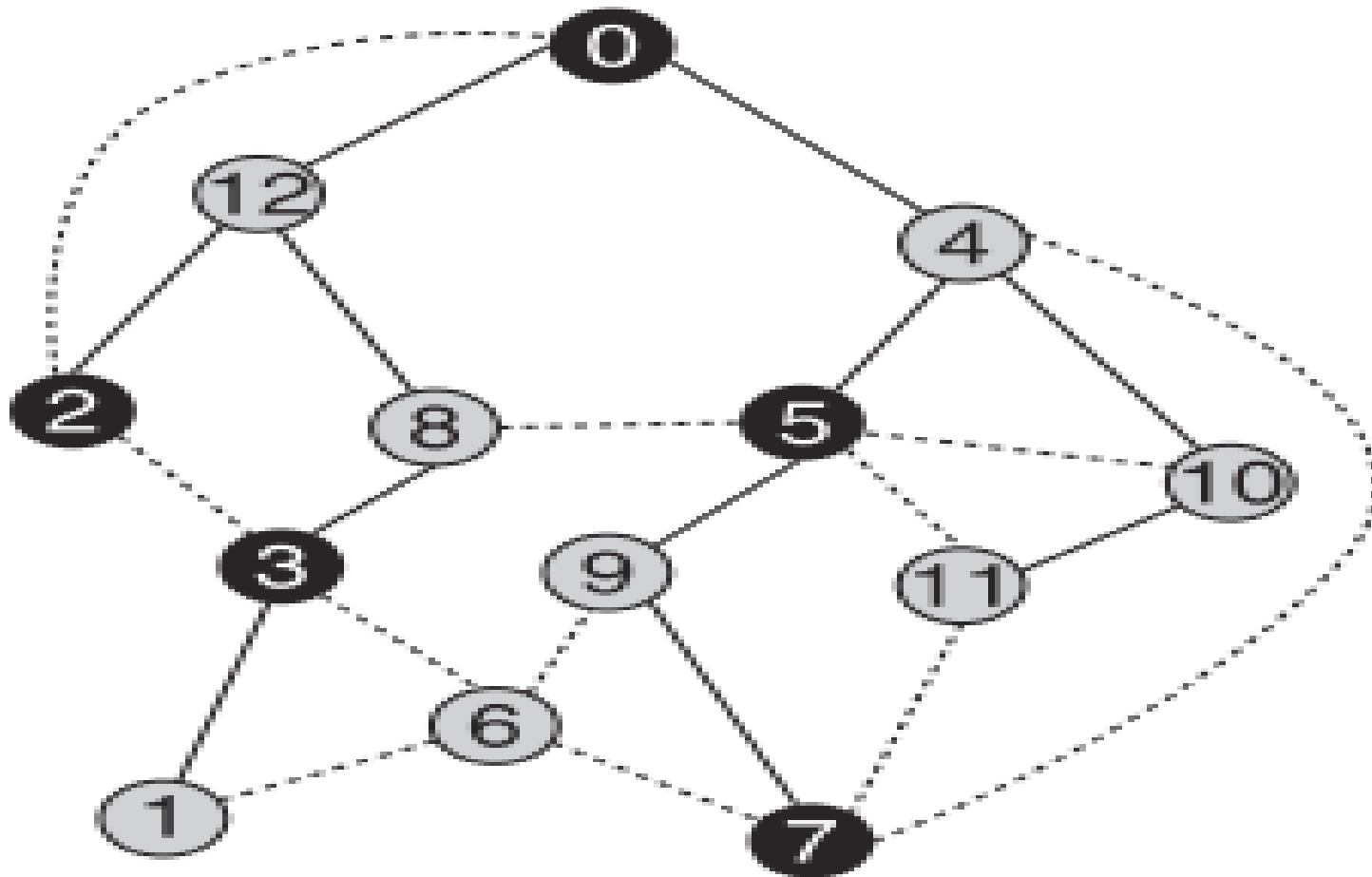
(a)

MIS Based Algorithm



(b)

MIS Based Algorithm



(c)