

Algorithm 1 Synchronous BFS Algorithm

- (1) message formats: FORWARD(source, level, parent), BACKWARD(source,destination)
- (2) initially: id is the unique node identifier; parent $\leftarrow \infty$; children $\leftarrow 0$; backward_children $\leftarrow 0$; others $\leftarrow 0$; neighbors is the set of collected sources of HELLO messages; forward_sent \leftarrow false; forward_received \leftarrow false;
- (3) sink node multicasts FORWARD(0,0, ∞) to neighbors

- (4) upon a node receives FORWARD(source, p_level ,p_parent) message
 - (5) forward_received \leftarrow true
 - (6) if parent = ∞ then
 - (7) parent \leftarrow source; level \leftarrow p_level + 1;
 - (8) else if p_parent = id then
 - (9) children \leftarrow children \cup source
 - (10) else others \leftarrow others \cup source
 - (11) end if
 - (12) end upon

- (13) upon a new period starts
 - (14) if forward_sent = false \wedge forward_received = true then
 - (15) forward_sent \leftarrow true; multicast FORWARD(id,level,parent) to neighbors
 - (16) if neighbors=children \cup others \cup {parent} and backward_children = children then
 - (17) send BACKWARD(id,parent) to parent; terminate execution
 - (18) end if
 - (19) else if backward_children = children then
 - (20) if(id != sink) send BACKWARD(id,parent) to parent end if
 - (21) terminate execution
 - (22) end if
 - (23) end upon

- (24) upon a node receives BACKWARD(source, p_parent) message
 - (25) if p_parent = id then backward_children \leftarrow backward_children \cup source end if
 - (26) end upon