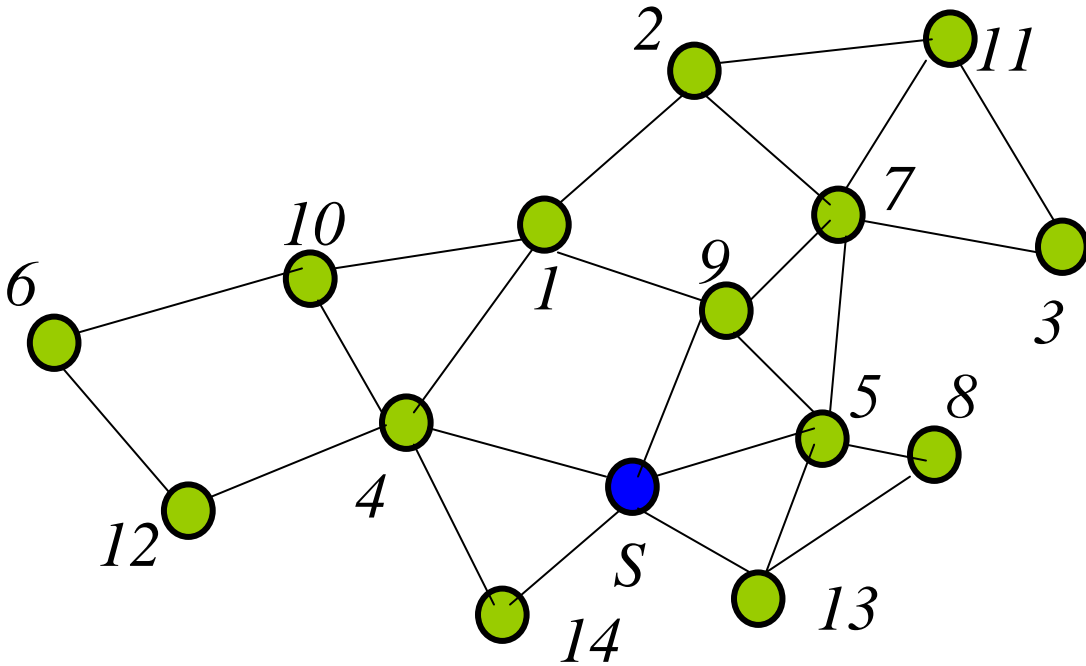


SOLUTIONS

Wireless Ad Hoc Networking: Quiz 1, October 7, 2004

Closed book exam, time: 50 minutes

Name: _____ Student number: _____



1. Follow neighbor elimination based broadcasting on above figure, with S as the source node. The key for timeout comparisons is $(timeout, ID)$; that is, if timeouts are same, node with lower ID number will transmit first. For timeout, use formula $timeout = 1 / (\text{number of uncovered neighbors})$. List nodes that will retransmit in the process, in the order of retransmissions.

Order: 4, 5, 1, 7, 10, 12

S transmits: 14 out, 4: $1/3$, 9: $1/2$, 5: $1/2$, 13: $1/1$

4 transmits: 12: $1/1$, 10: $1/1$, 1: $1/2$, 9: $1/2 - 1/3$, 5: $1/2 - 1/3$, 13: $1/1 - 1/3$

5 transmits: 8 out, 13 out, 7: $1/3$, 12: $1/1 - 1/6$, 10: $1 - 1/6$, 1: $1/2 - 1/6$, 9: $1/1 - 1/3 - 1/6$

1 transmits: 2: $1/2$, 7: $1/3 - 1/3$, 12: $1 - 1/6 - 1/3$, 10: $1 - 1/6 - 1/3$ 9 out

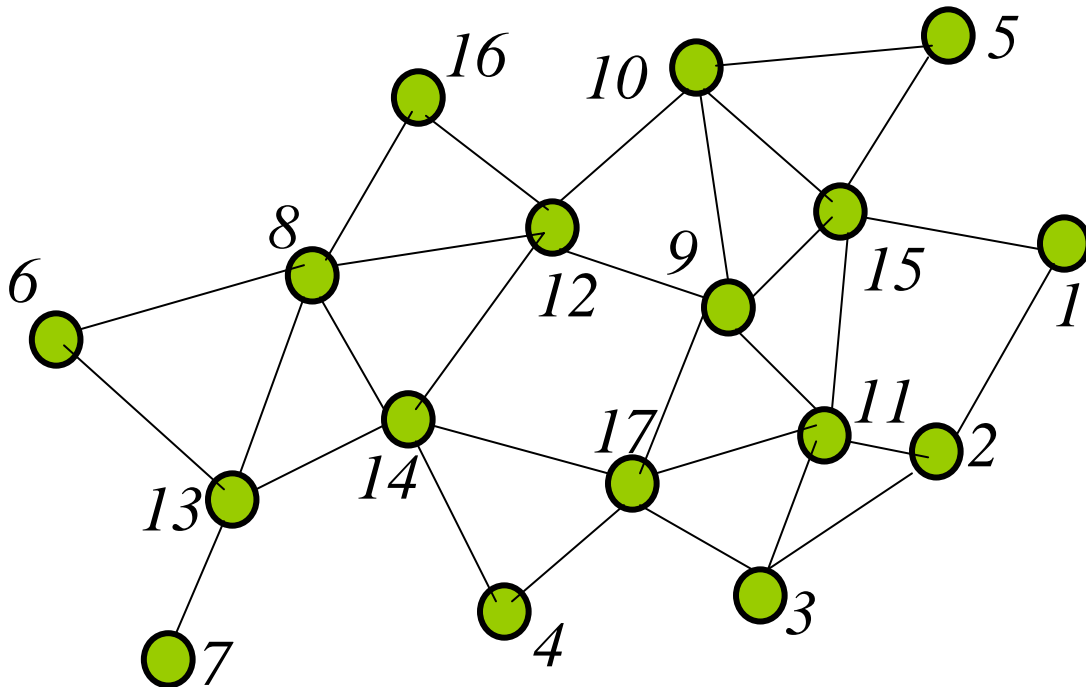
7 transmits: 2 out 11 out 3 out 12: $1 - 1/6 - 1/3$ 10: $1 - 1/6 - 1/3$

10 transmits: 12: $1 - 1/6 - 1/3 - 1/2 = 0$

12 transmits (to cover 6)

Name: _____ Student number: _____

2. Follow clustering algorithm described in class in the given example. Use key=(degree, ID) in deciding roles, where degree is the initial number of neighbors of each node (this is *not* the number of undecided neighbors). Show clusters and clusterheads that are created.



Solution 1, lower ID preferred for CH: 9, 8, 7, 4, 5, 2

Solution 2, higher ID preferred for CH: 17, 15, 12, 13, 2

3. Show/list nodes that belong to connected dominating set, following generalized covering rule from the class. Node I is covered by neighboring nodes A, H, ... if A, H, ... are connected, any neighbor of I is neighbor of one of A, H,.. and $key(I) < \min(key(A), key(H), \dots)$. Use key=ID, ordered numerically (1<2<3<...). Node I is also considered covered if it does not have two unconnected neighbors. For each node not in connected dominating set, list neighbors that cover it.

DS={1,2,10,11,12,13,14,15,17}

Not intermediate: 4, 5, 6, 7, 16

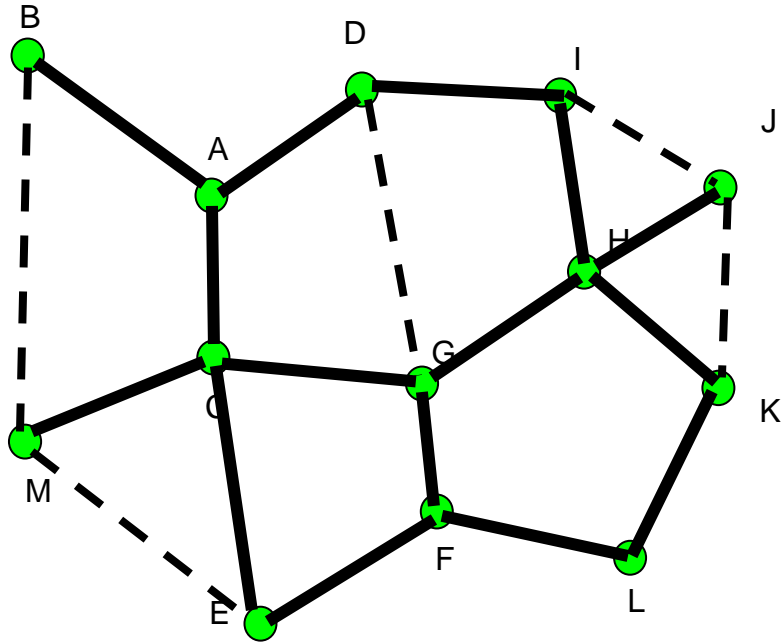
3 covered by 11

8 covered by {12, 13, 14}

9 covered by {10, 15, 11}

Name: _____ Student number: _____

4. Draw Gabriel graph (GG) and Relative neighborhood graphs (RNG) for the network below. Simply draw edges that you believe are in the GG and RNG, respectively.



RNG (full lines only) is a subset of GG (all lines).

Name: _____ Student number: _____

5. Follow *neighbor elimination and dominating set based broadcasting* on given figure, with S as the source node. The key for timeout comparisons is $(timeout, ID)$; that is, if timeouts are same, node with lower ID number will transmit first. For timeout, use formula $timeout = 1 / (\text{number of uncovered neighbors})$. List nodes that will retransmit in the process, in the order of retransmissions.

Non-intermediate: 8, 14, 3 (they will not retransmit regardless of DS consideration)

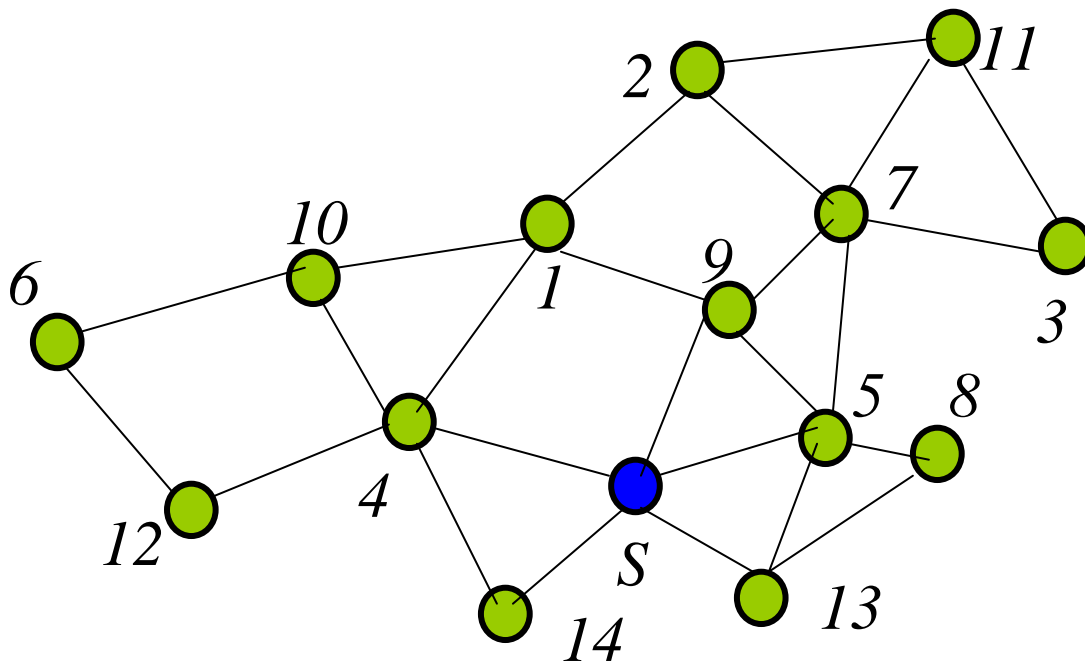
Solution 1: key = -ID (lower ID has priority): DS = {1, 2, 4, 5, 6, 7, 9, 10, 12, 15}

11 covered by 2,3,7; 13 covered by 5, 8

Order same as in Q1.

Solution 2: key = ID (higher ID has priority for inclusion in DS, but lower priority for NE based retransmission) DS = {1,4,6,7,9,10,11,12,13,15}

Order: 4, 9, 7, 13, 1, 10, 12.



6. Show routes taken by Greedy, DIR, Face, and GFG routing schemes in the example below, from source S to destination D. Apply both 'before crossing' and 'after crossing' variants for face/GFG schemes (the one illustrated in class), starting with neighbor that has smaller angle among two on starting face. Note that face routing uses only edges of Gabriel graph (some edges in figure are not in GG, they are drawn as dotted lines).

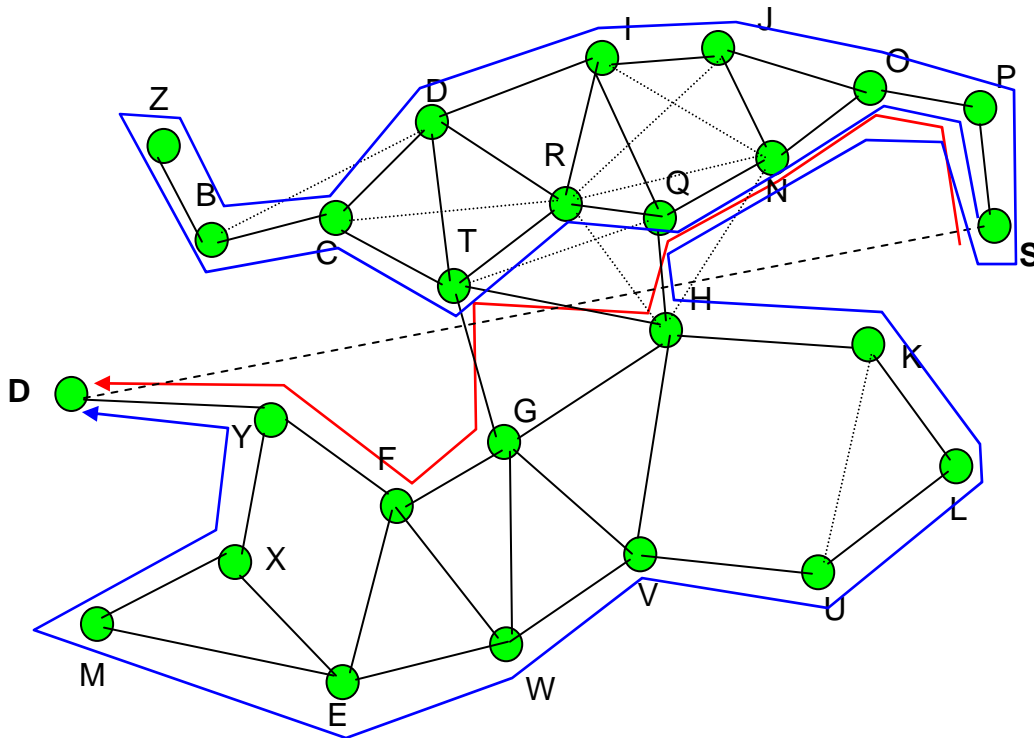
DIR stops when the best choice, by the method, is to return the message to the previous node.
 Greedy stops when there is no closer neighbor to destination than current node.

Greedy: Fails, since $PD > SD$.

DIR: SPONQTCBZB fails

Face before crossing: SPONQRTCBZBCDIJOPSPONQHKLUVWEMXYD.

Face after crossing: SPONQHTGFYD



GFG before crossing: fail (greedy) – (face): SPO, (greedy):ONRCB, (face): BZBCDIJOPSPONQHKLUVWEMYD.

GFG after crossing: fail (greedy) – (face): SPO, (greedy):ONRCB, (face): BZBCDIJOPSPONQHKLUVWEMYD.

Line BD was not crossed, so routes are same.

