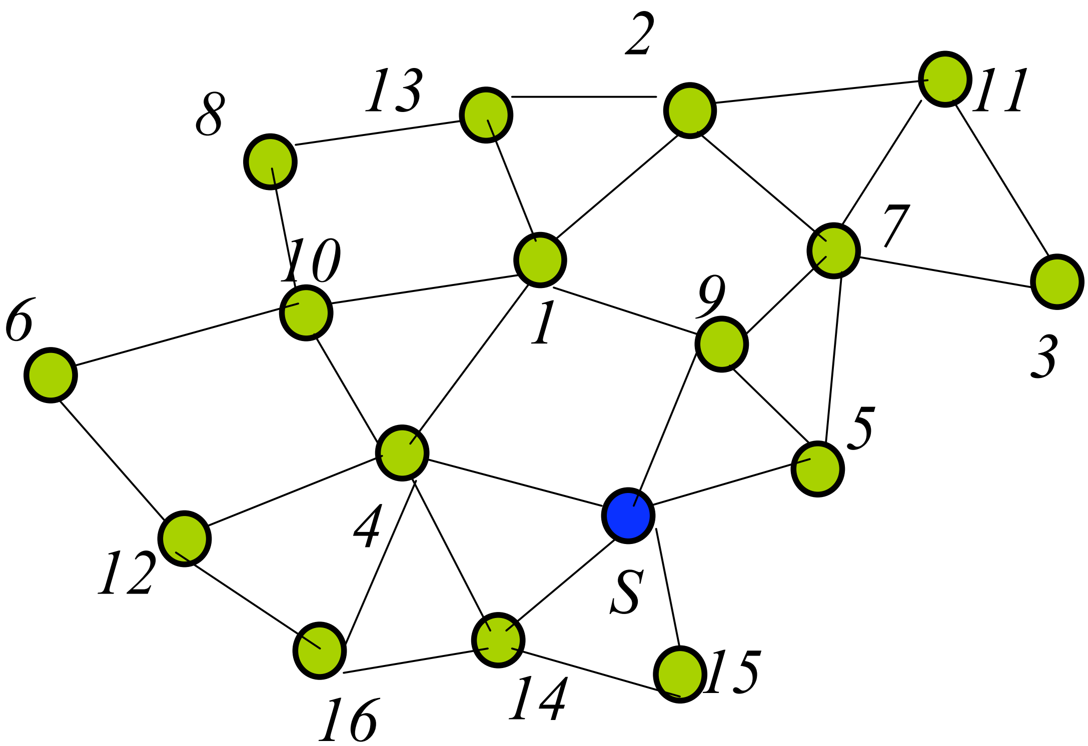
Wireless Ad Hoc Networking: Quiz 1, October 6, 2006
Closed book exam, time: 100 minutes

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/(number of uncovered neighbors)*. List nodes that will retransmit in the process, in the order of retransmissions.

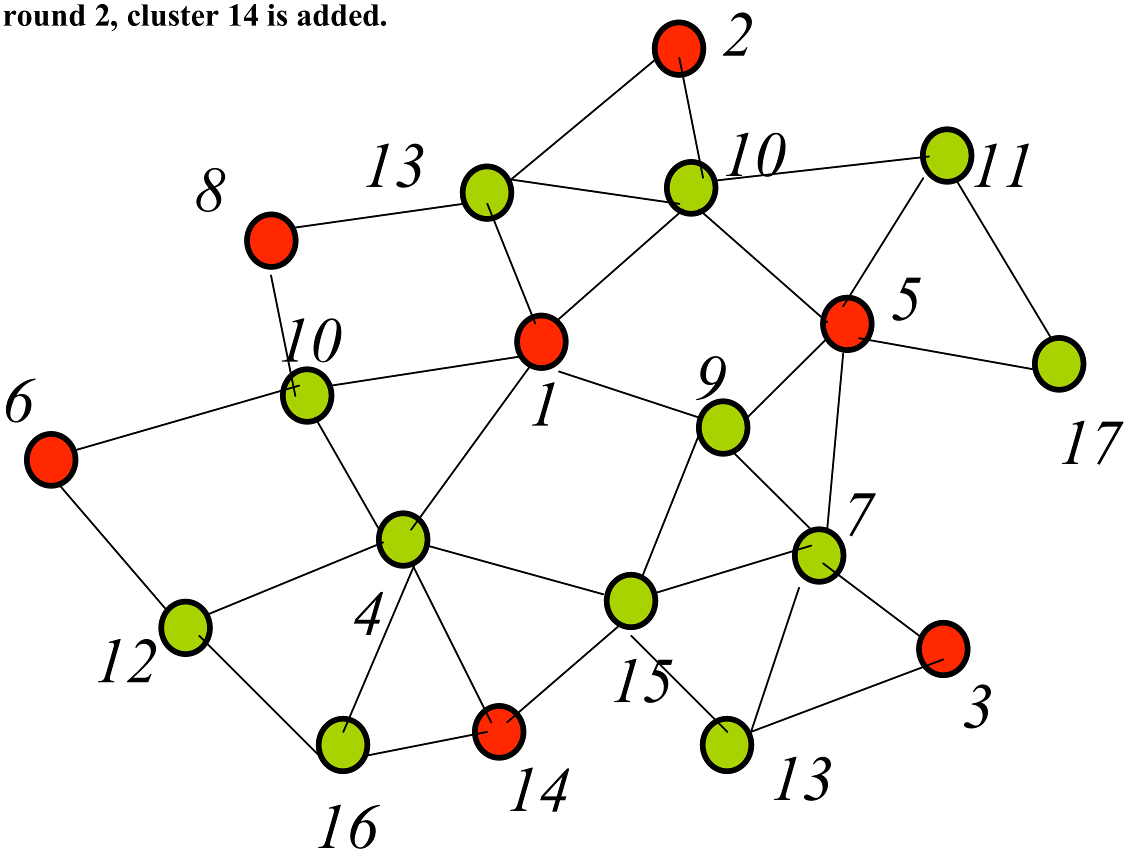
S transmits: 15 out, 4: ¼, 14: 1/1, 9: ½, 5: 1/1
4 transmits: 16 out, 12: 1/1, 10: ½, 1: 1/3, 14 out, 9: ½-1/4=1/4, 5: 1/1-1/4=3/4
9 transmits: 7: 1/3, 5 out; 1: ½-1/4=1/4, 12: 1-1/4=3/4; 10: ½-1/4=1/4;
1 transmits: 2: ½, 13: 1/1, 10: 1/4-1/4=0, 7: 1/3-1/4=1/12, 12: ¾-1/4=1/2
10 transmits: 8: 1/1, 6: 1/1, 12: ½, 7: 1/12, 13: 1/1, 2: ½
7 transmits: 3, 11, 2: out, 8: 1/1-1/12=11/12, 6: 1/1-1/12=11/12, 12: ½-1/12=5/12, 13: 1/1-1/12=11/12
12 transmits: 6 out, 8: 6/12=1/2, 13: 6/12=1/2
8 transmits: 13 out.

20 marks

Name: ____________________ Student number: ___________________

2. Follow clustering algorithm described in class in the given example. Use key= ID in deciding roles. Show clusters and clusterheads that are created. 20 marks

1, 2, 3, 5, 6 and 8 create clusters in parallel in round 1.
In round 2, cluster 14 is added.

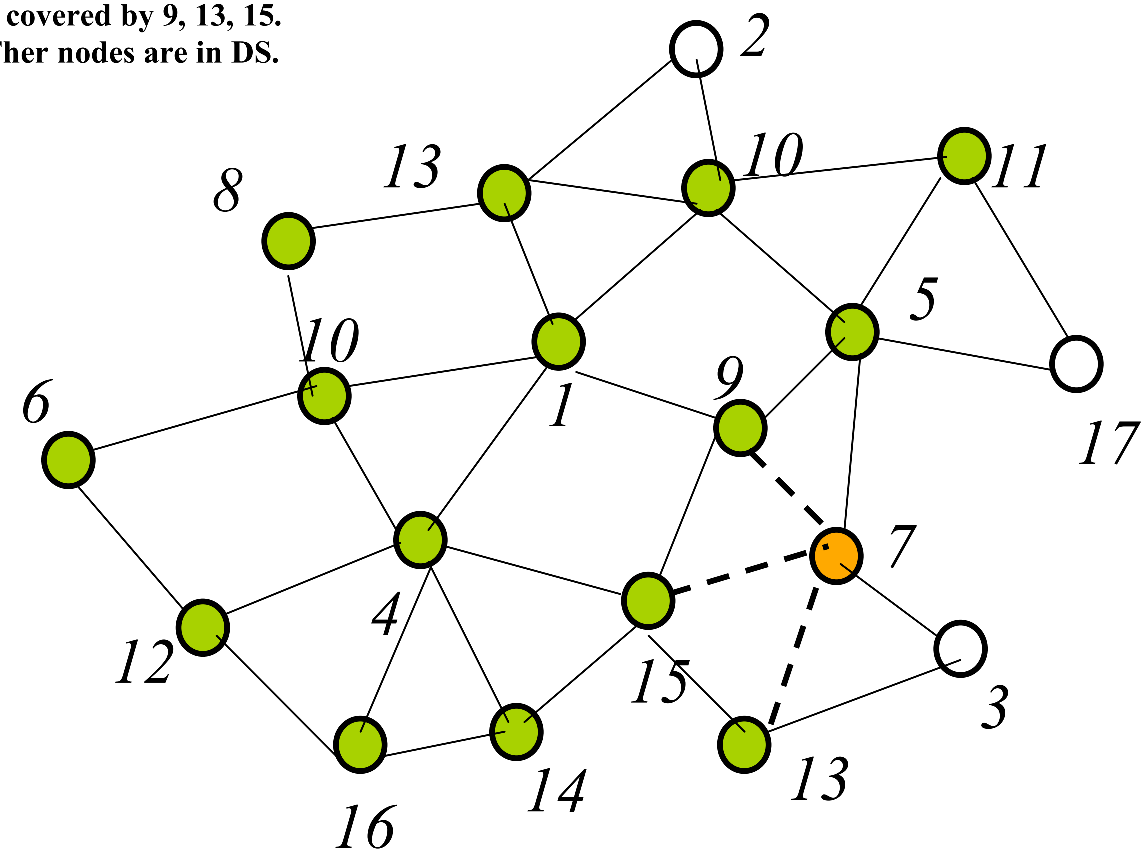


Name: ____ Student number:

20 marks

3. Show/list nodes that belong to connected dominating set, following generalizede 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),…). Use key=ID, ordered numericaly (1<2<3<…). Node I is also considered covered is it does not have two unconnected neighbors. For each node not in connected dominating set, list neighbors that cover it. This figure shows node keys.

2, 3, 17 do not have two unconnected neighbors.
7 covered by 9, 13, 15.
Ther nodes are in DS.



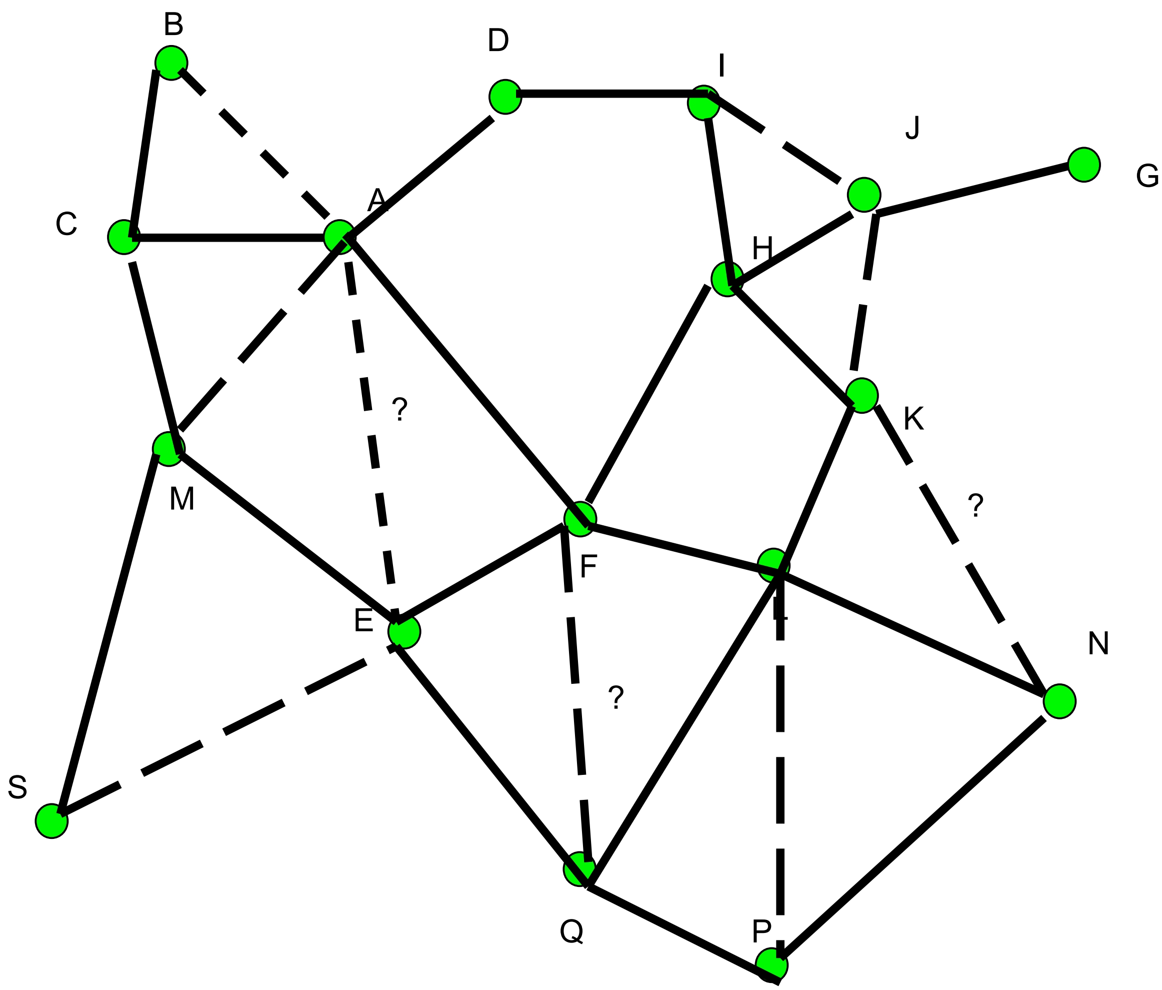
Name: ____ Student number: _________________

4. a) Draw Gabriel graph (GG) for the network below. Simply draw edges that you believe are in the GG. Edge XY is in GG if and only if there is no node inside circle with diameter XY.

b) Draw RNG (relative Neighborhood graph), defined as follows: Edge XY is in RNG if and only if there is no triangle XYZ so that XY is the longest edge in that triangle. That is, XY>XZ and XY>YZ for some node Z then XY is not in RNG.

c) Is RNG subset of GG? Why? 7+7+11=25 marks

If an edge XY des not belong to GG then there exists a node Z such that Z is inside the circle whose diameter is XY. Then XZ<XY and YZ<XY, and XY is the longest edge in triangle XYZ. Therefore XY is then not in RNG.



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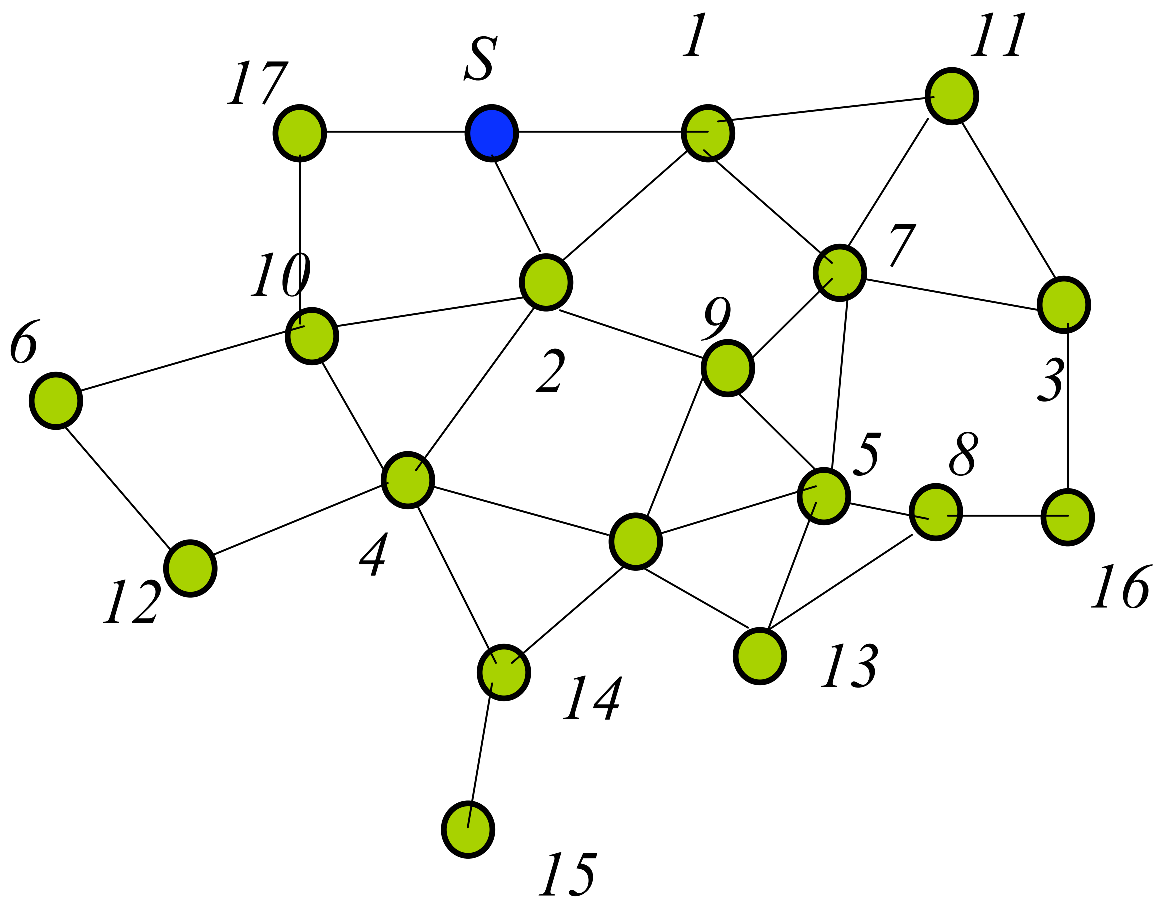
5. Follow *neighbor elimination and dominating set based broadcasting* on given figure, with S as the source node. The key for timeout comparisons is *(timeout, ID);* that is, if timeouts are same, node with higher ID number will transmit first. For timeout, use formula *timeout=1/(number of uncovered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



Using definition in Q2, all nodes except 15 (no two unconnected neighbors) and 5 (covered by 9, 13, 18) are in DS. Then follow neighbor elimination as in Q2.
The order is 2, 1, 9, 4, 17, 11, 10, 18, 14, 12, 3, 13, 16.

6. Show routes taken by Greedy, DIR, and GFG routing schemes in the example below, from source S to destination D. Apply three variants of recovery scheme: ‘left hand’, ‘right hand’, and ‘smaller angle’ each time face routing starts. Note that face routing uses only edges of Gabriel graph.
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.
Edges are not drawn, but transmission radius is indicated and needs to be applied.
25 marks; DIR in blue; greedy in red; face in green (left-hand rule)
Transmission radius