Localized Construction of Connected Dominating Set in Wireless Networks

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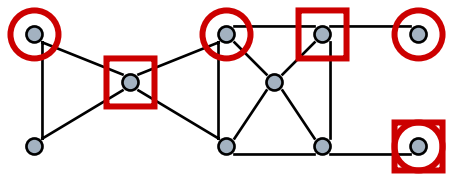
Algorithm Classification

- Distributed VS. Centralized
- Completely localized VS. Serialized

	PR	*Stage*	*Connectivity Information*
Wu's	**O(n)**	**1-stage**	**Considered**
Alzoubi's	**192**	**2-stage**	**Not-considered**
r-CDS	**172**	**1-stage**	**Considered**

Key idea



Maximal Independent Set (MIS) is a maximal set of pair-wise non-adjacent nodes.

MIS ⟷ DS

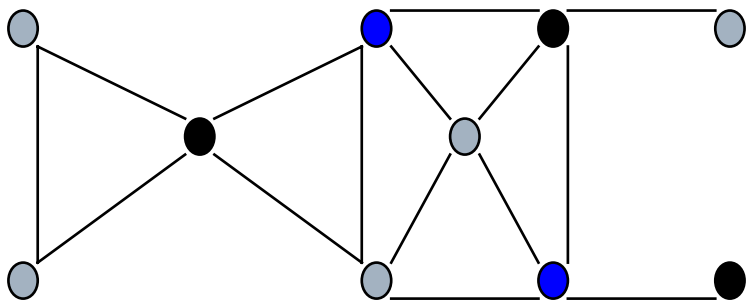
Notations

Black nodes: MIS nodes.

Blue nodes: nodes connecting black nodes.

Grey nodes: dominatee nodes.

Black nodes + Blue nodes = dominating nodes (CDS)

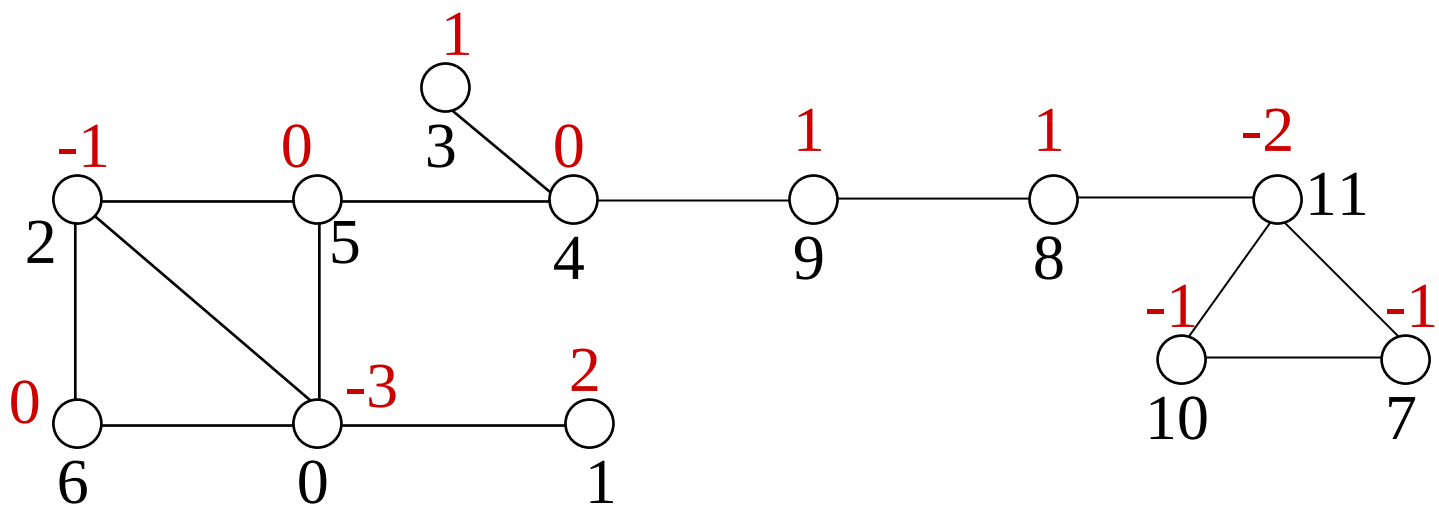


r-CDS

For each node u

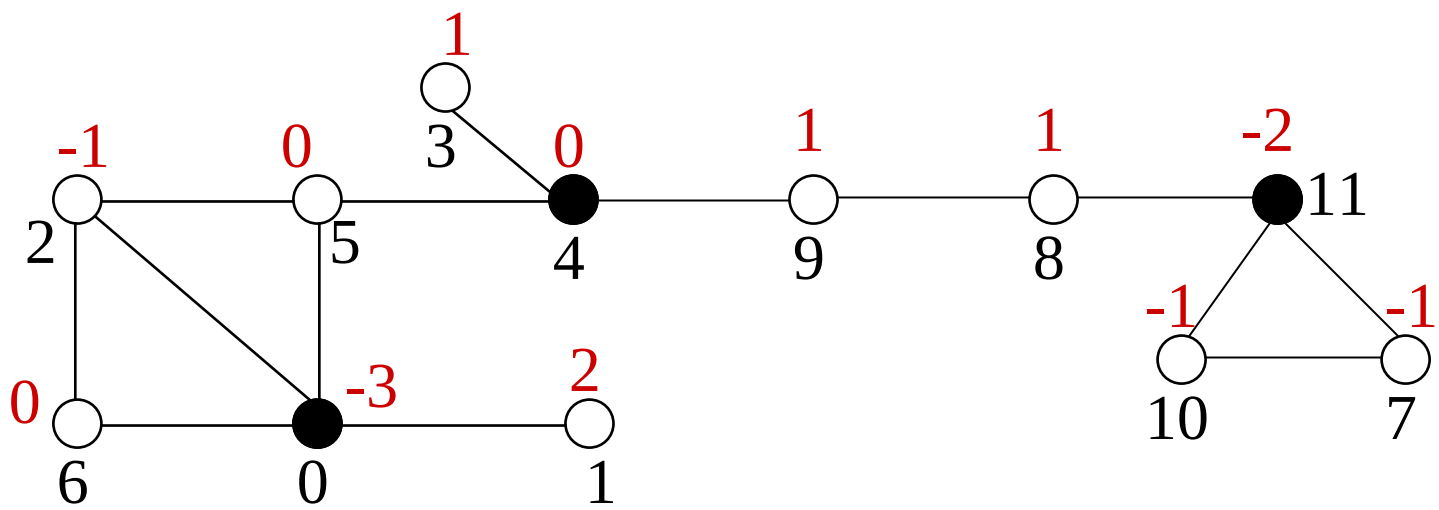
r(u) = the number of 2-hop-away neighbors – *d(u)*

where *d(u)* is the degree of node *u*



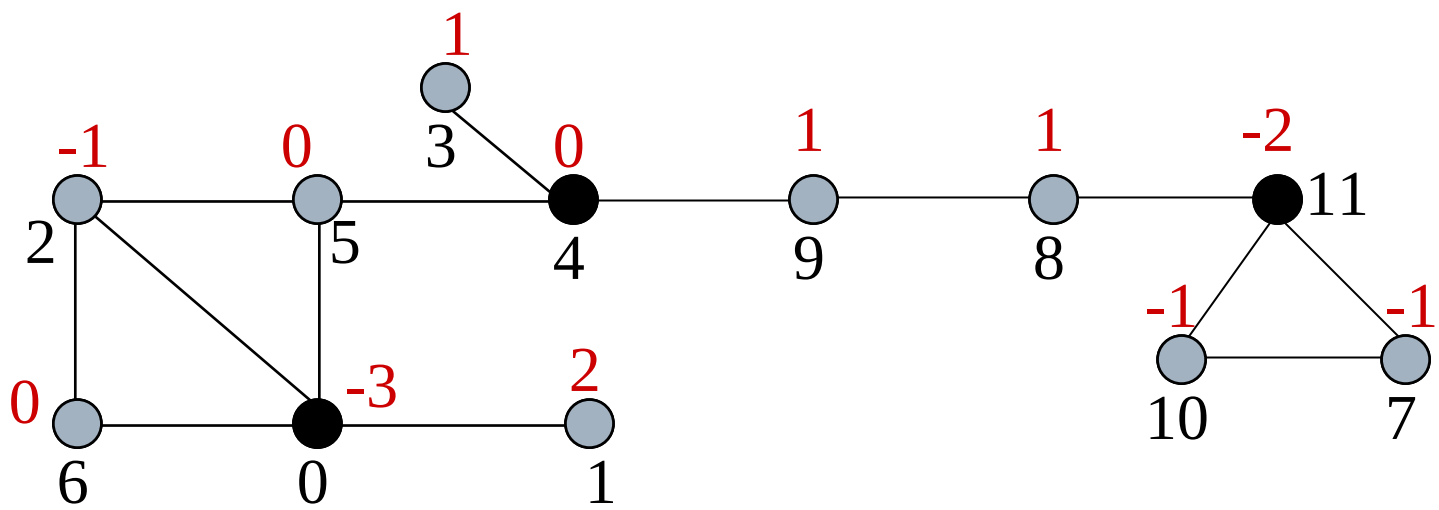
r-CDS (Cont.)

Node *u* with the smallest <*r*, *deg*, *id*> within its neighborhood becomes black and broadcast a BLACK message where *deg* is the **effective degree**.



r-CDS (Cont.)

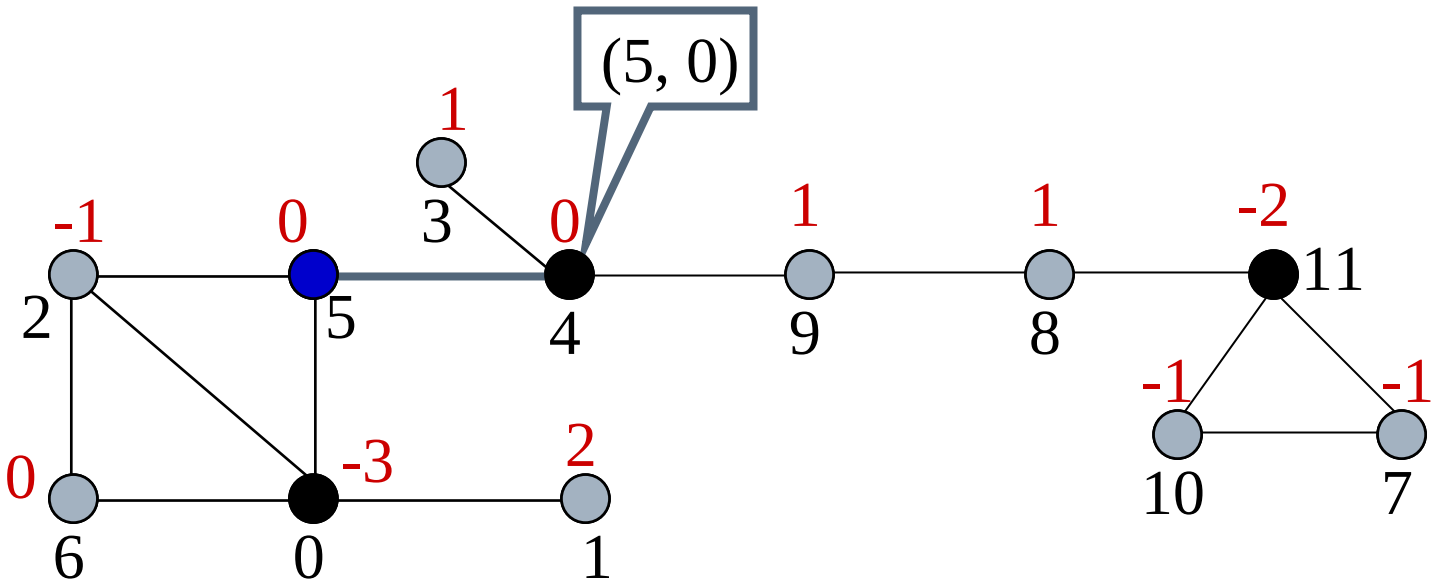
If *v* receives a BLACK message from *u*, *v* becomes grey and broadcasts a GREY message containing (*v*, *u*).



r-CDS (Cont.)

- black node *w* receives a GREY message (*v, u)*
- *w* not connected to *u*

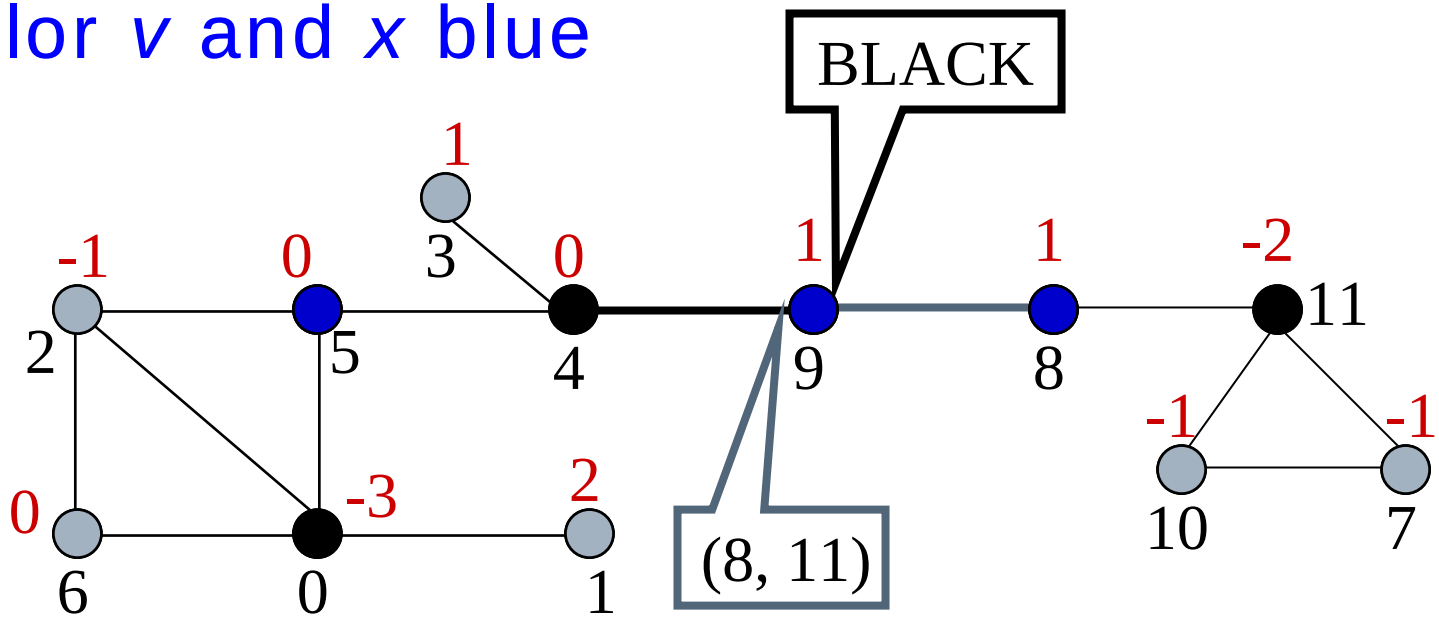
Color v blue



r-CDS (Cont.)

- *v* has received a GREY message (*x*, *y*)
- *v* receives a BLACK message from *u*
- *y* & *u* not connected

Color *v* and *x* blue



Analysis

Lemma 1 All the black nodes form an MIS.

- No 2 adjacent white nodes become black simultaneously.
- All the neighbors of a black node become grey.
- Black nodes form an independent set.
- Grey nodes can no longer become black.

Analysis (Cont)

Lemma 2 Let d denote the number of hops between any pair of black nodes, then d=2 or d=3.

- Black nodes form an MIS.
- A grey node must have a black neighbor.

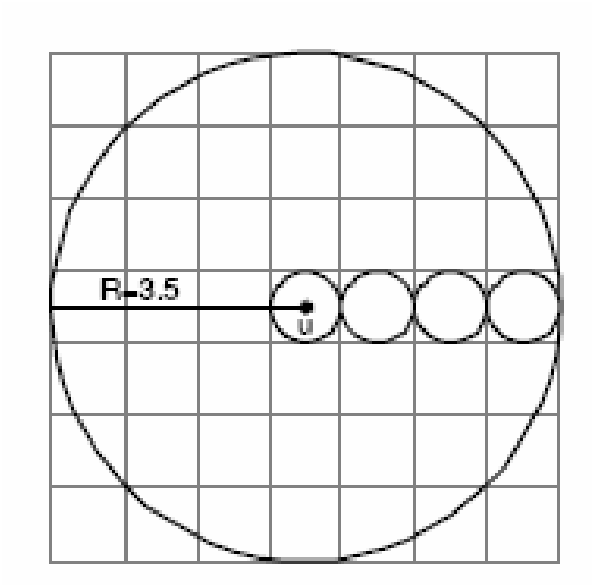
Analysis (Cont)

Theorem 1 All the black nodes and blue nodes from a CDS.

Theorem 2 The time complexity is $O(\Delta)$ where is the maximum node degree and the message complexity is $O(n\Delta^2)$.

Analysis (Cont)

Lemma 3: Let *S* be any MIS of a UDG *G.* For any node *u* in *S,* the number of the nodes in S that are at most three hops away from *u* is at most 42.



$$D = \frac{nd^2\pi}{4A(Q)}$$

$$D \leq \frac{n}{\left[1 - \frac{\sqrt{3}}{2} + \sqrt{\frac{3}{4} + \frac{2\sqrt{3}}{\pi}(n-1)}\right]^2}$$

where D is a maximum density of packing n equal circles in another larger circle.

Analysis (Cont)

Theorem 3 The performance ratio of r-CDS is 172.

- The size of any MIS *S* in a graph is at most $4opt + 1$ where *opt* is the size of any optimal CDS of the graph.
- $|C| \leqslant 2*42|S|/2 + |S| \leqslant 172opt + 43$