

Preventing selfishness in Open Mobile Ad-Hoc Networks

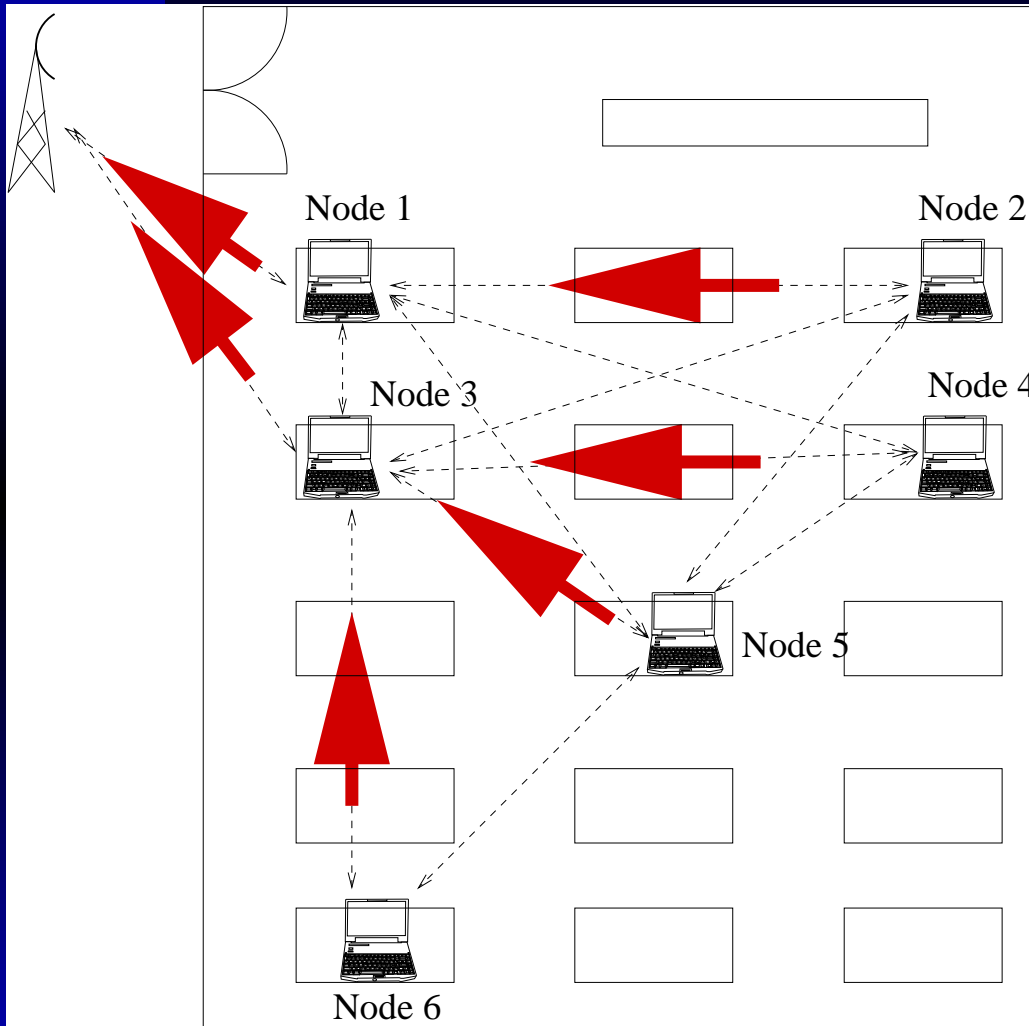
or
a motivation for lazy ants

Hugo Miranda and Luís Rodrigues

hmiranda@di.fc.ul.pt

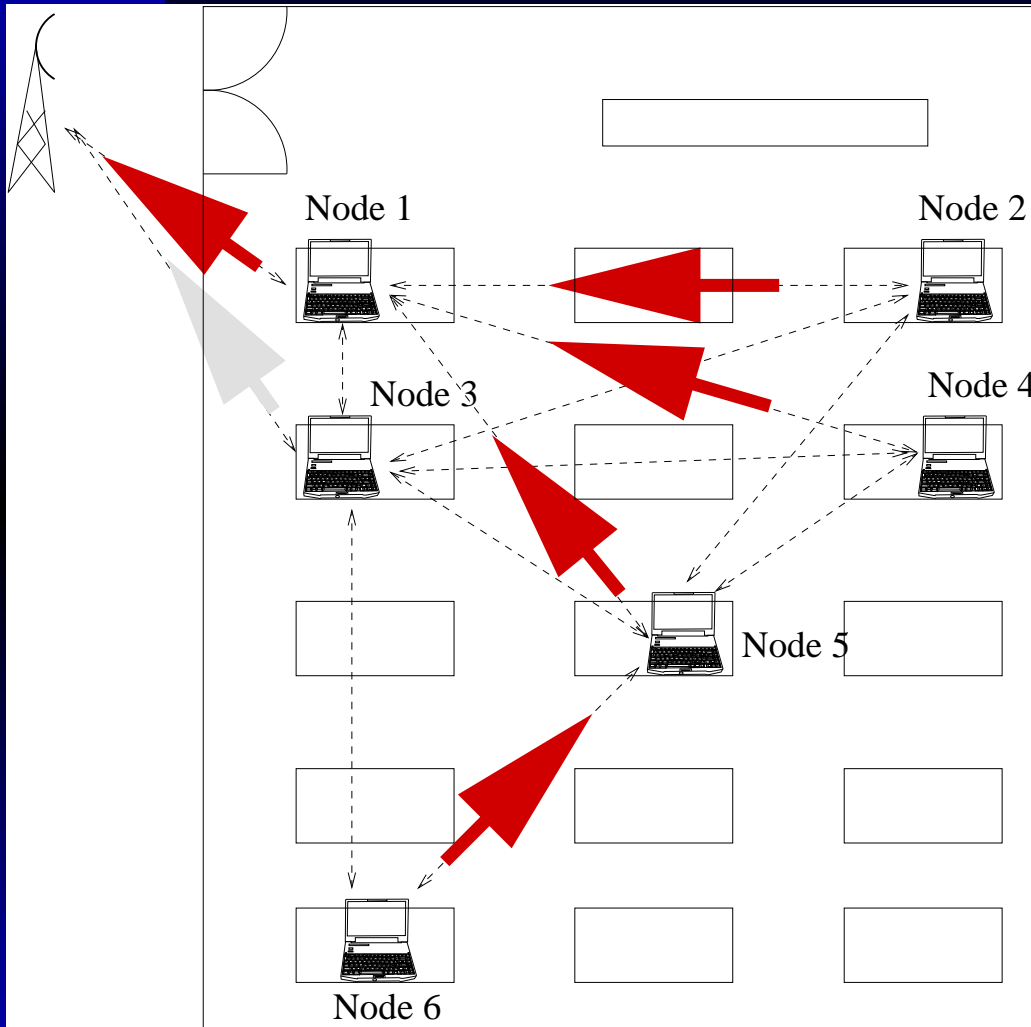
DIAL-NP - LaSIGE - Univ. Lisboa, Portugal

Motivation



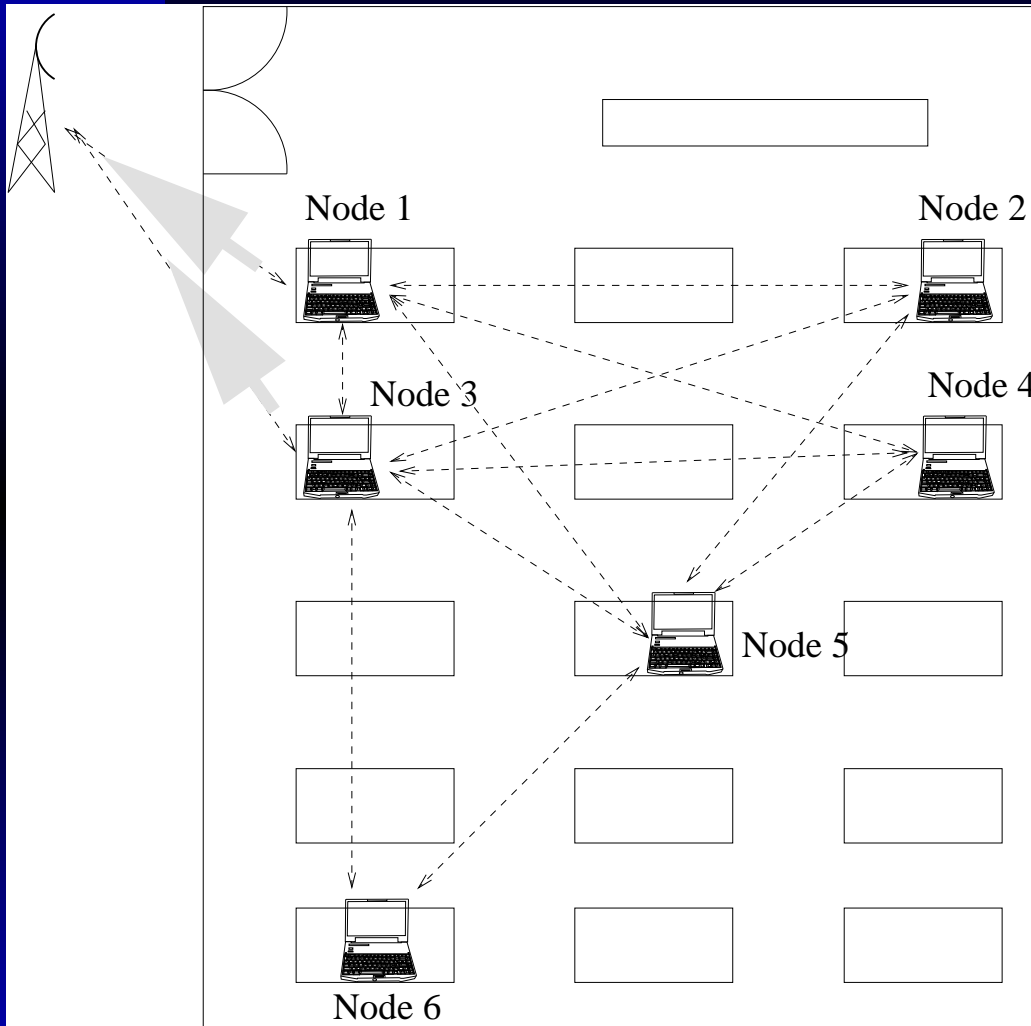
- Nodes establish a cooperative ad-hoc network.

Motivation



- Nodes establish a cooperative ad-hoc network.
- Node 3 refuses to forward messages. Routes previously using Node 3 are moved to Node 1.

Motivation



- Nodes establish a cooperative ad-hoc network.
- Node 3 refuses to forward messages. Routes previously using Node 3 are moved to Node 1.
- Node 1 gets overloaded and begins to refuse to forward messages. Only Nodes 1 and 3 reach the base station. Ad-hoc network becomes useless.

Related work

- Path rater
 - Notifies routing protocols to avoid selfish nodes;
 - Selfish nodes may freely use the network;
- Confidant
 - Nodes refuse to forward messages from those with a bad reputation;
 - Nodes are always forbidden to be selfish (no fairness);

Related Work - cont.

- Terminodes
 - Virtual currency possibly mapped in real money;
 - Each hop of a message would charge some *nuglets (beans)*;
 - Tamper-proof device prevents frauds
 - Requires PKI

Desirable properties

- Fair selfishness, if some node becomes highly loaded;
 - Nodes should remember the past behavior of other nodes;
- The protocol should be optional;
- Low power consumption;
- Payment should be independent of nodes position;
- Accept selfish behavior of some nodes;

Algorithm overview

Periodically, each node broadcasts:

- The set of neighbors to whom he provides services (S_p);
- The list of neighbors to whom he refuses to provide services (S_r);
- The list of nodes that lied to him (S_l);

For each node, each other node keeps S_p and S_r . The set S_l is used to change S_p and S_r of the liars.

Who's selfish?

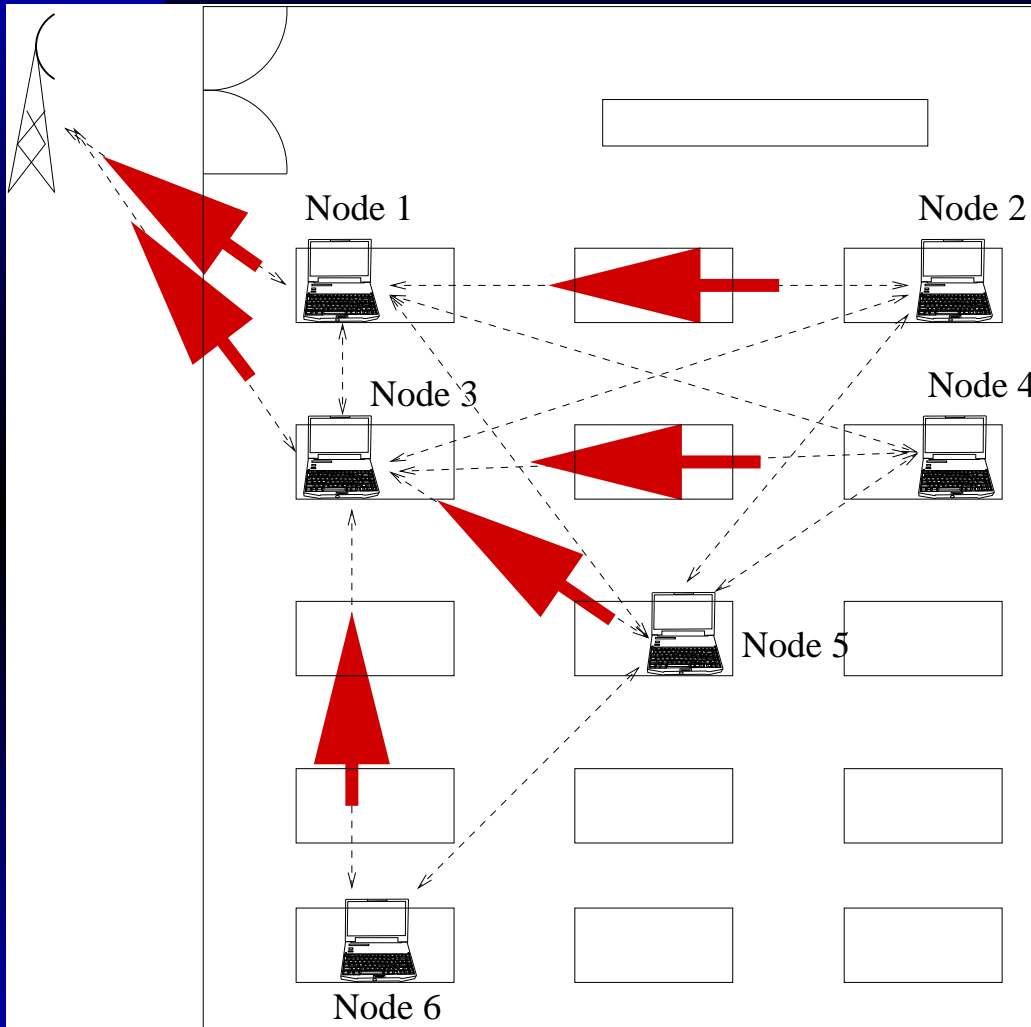
- Decision is taken locally. Nodes with the local ratio:

$$\frac{\#S_p}{\#S_p + \#S_r}$$

below an acceptable threshold will be considered selfish.

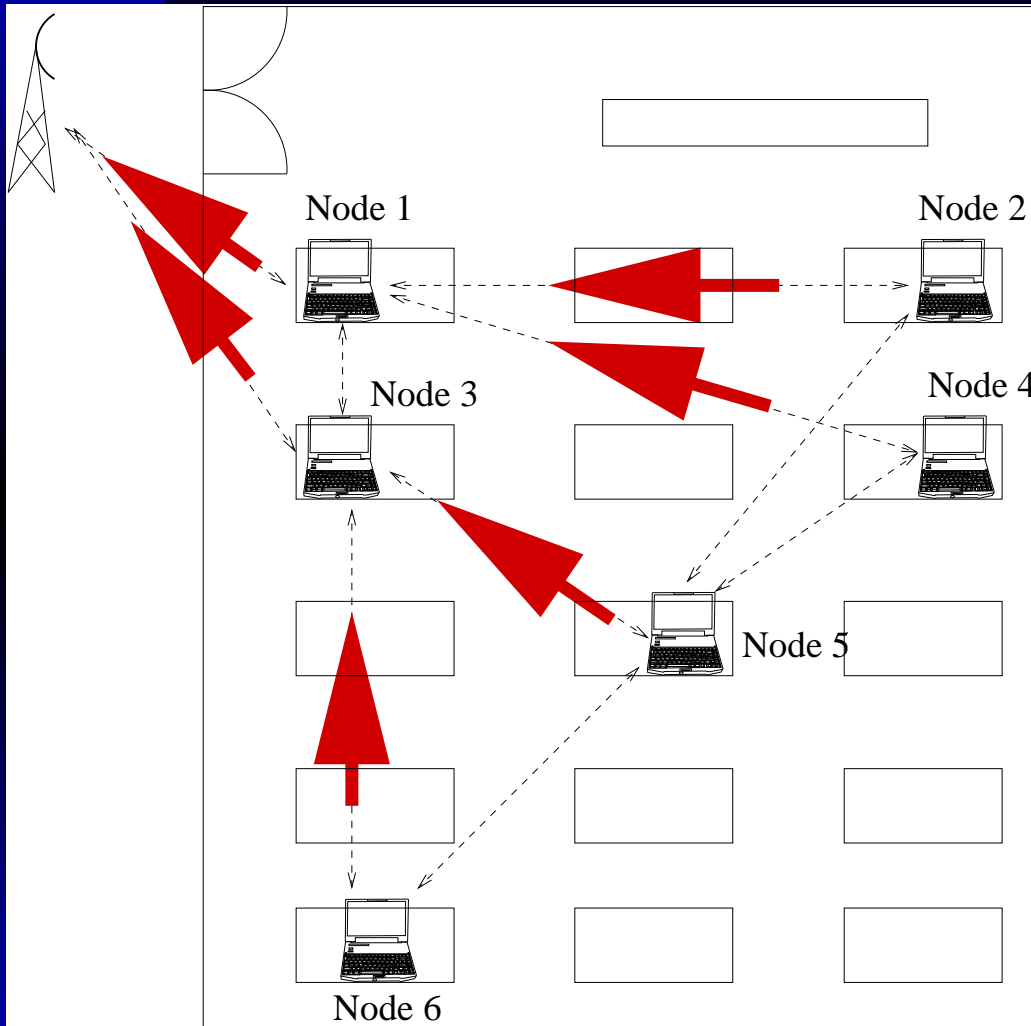
- Selfish nodes will only be able to send messages until they become even with each other node;

Example



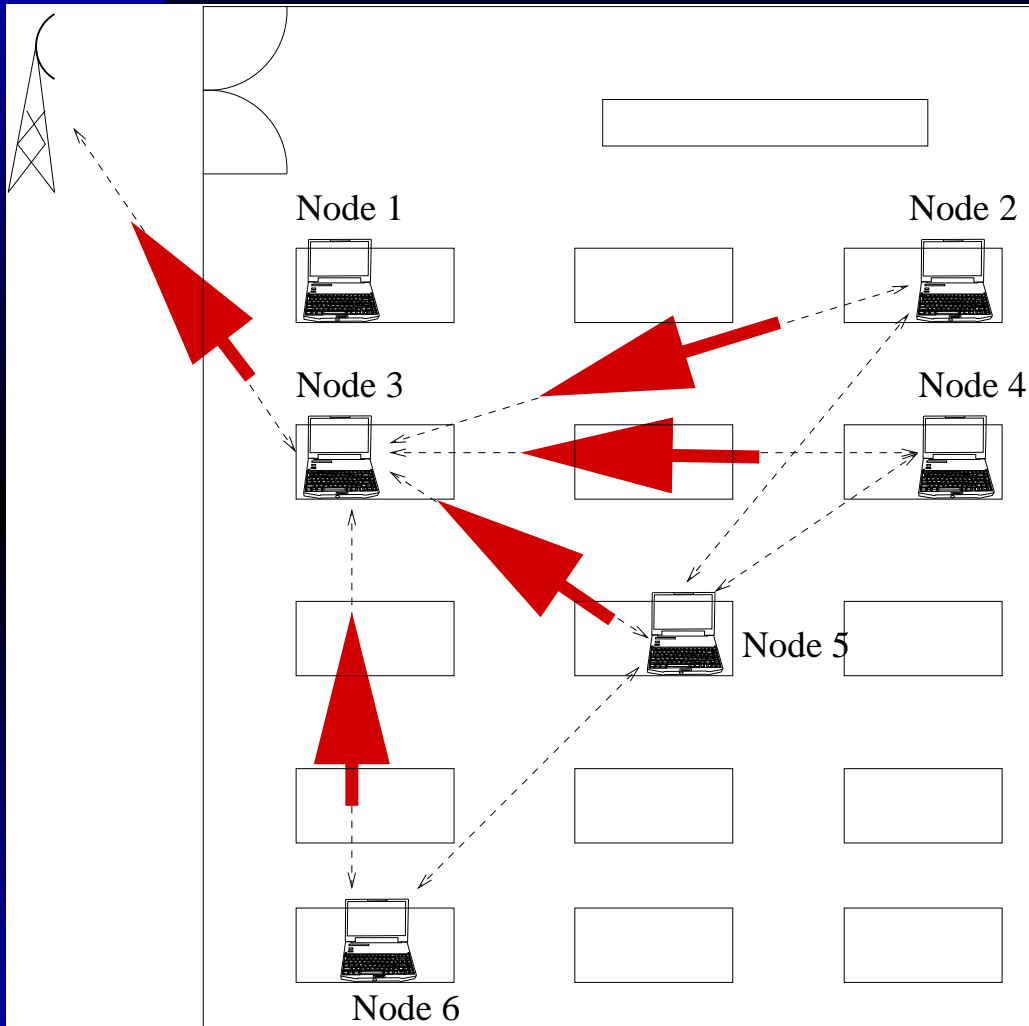
- Initial state.

Example



- Initial state.
- Node 3 finds that he is overloaded. Declares to be selfish for node 4. Other nodes understand the situation (the ratio for Node 3 is acceptable).

Example



- Initial state.
- Node 3 finds that he is overloaded. Declares to be selfish for node 4. Other nodes understand the situation (the ratio for Node 3 is acceptable).
- Node 1 declares to be selfish to other nodes. The Base Station refuses to forward messages for Node 1 (unacceptable ratio).

Other considerations

- Re-integration;
- Protocol transparency;
- Subverting the protocol;
- Integration with routing protocols
 - Tell to the protocol to discard routes including neighbor selfish nodes;
 - Do not forward route discovery messages issued by selfish nodes;
- Acceptable selfishness;

Conclusions & Future Work

- Selfishness prevention in MANETs is a new subject.
- The proposed protocol:
 - Does not require a PKI;
 - Tolerates fair selfishness, improving load balancing;
 - Uses one message per round;
 - Tolerates “node reintegration”;
 - Charges per message;
 - Tolerates “socially acceptable” selfishness;

Conclusions & Future Work

Waiting to be defined:

- How to make the protocol more robust;
- Validation of the protocol;
- Integration with routing protocols;
- Finding reasonable thresholds and timers;