Preventing selfishness in Open Mobile Ad-Hoc Networks

or

a motivation for lazy ants

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Motivation

- Nodes establish a cooperative ad-hoc network.

Nodes 1 and 3 reach the base station. Ad-hoc network becomes useless.
Motivation

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

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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:

\[
\frac{\#S_p}{\#S_p + \#S_r}
\]

bellow 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.

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).
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).
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- 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;