

Prevention of Denial of Service Attacks in MANET

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Security in MANET

- A priori trust (military, corporate)
 - Entity authentication \Rightarrow correct operation
 - But:
requirement for tamper-proof hardware and strong authentication infrastructure

- No a priori trust (metropolitan)
 - authentication does not guarantee correct operation
 - *cooperative security schemes*

Node Misbehavior

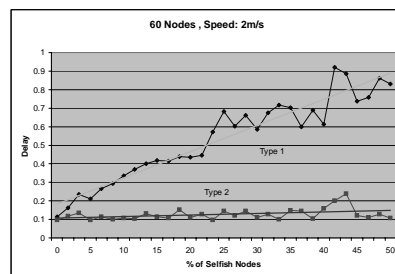
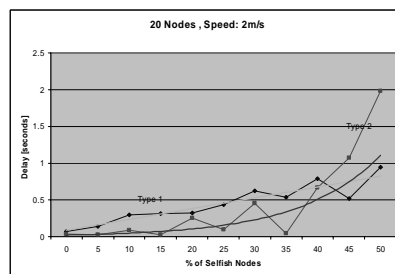
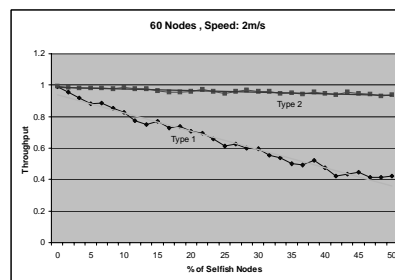
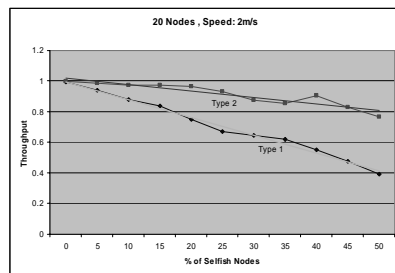
Selfish Nodes

- Do not cooperate
- Priority: battery saving
- No intentional damage to other nodes.
- **Attacks:**
 - passive denial of service
 - black hole
 - idle status

Malicious Nodes

- Goal: damage to other nodes
- Battery saving is not a priority
- **Attacks:**
 - active denial of service
 - traffic subversion
 - attacks exploiting the security mechanism

Example: passive denial of service attacks



Cooperation enforcement in MANET

- Prevent network/service utilization by misbehaving nodes.
- Approaches:
 - metering (currency)
 - **monitoring**

CORE: design principles

Utilization \longleftrightarrow Contribution

Local Reputation as a measure of a node's behavior.

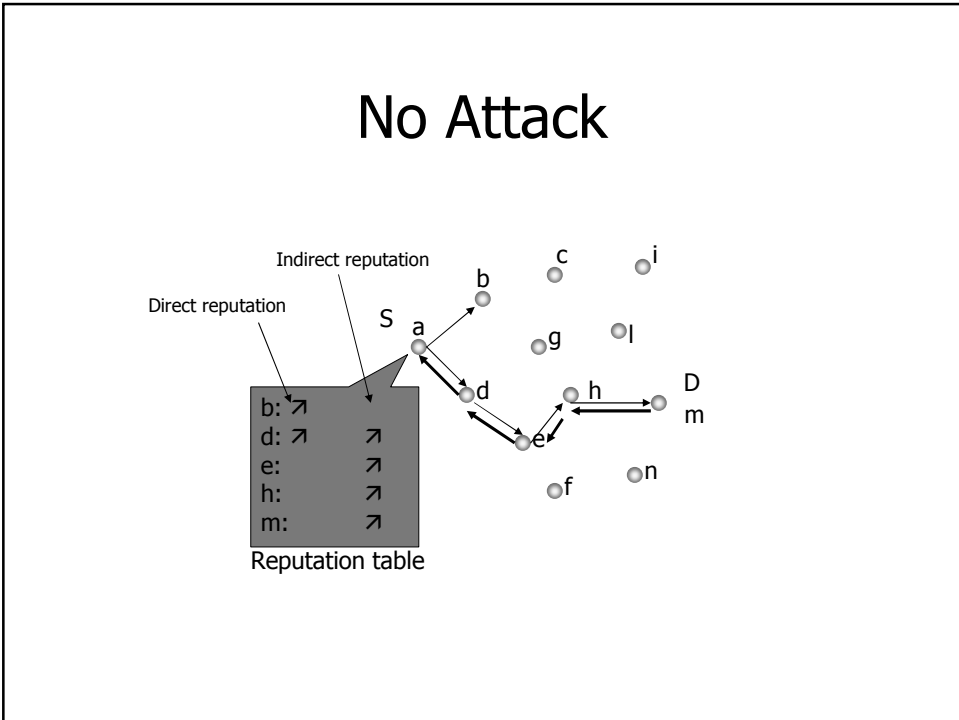
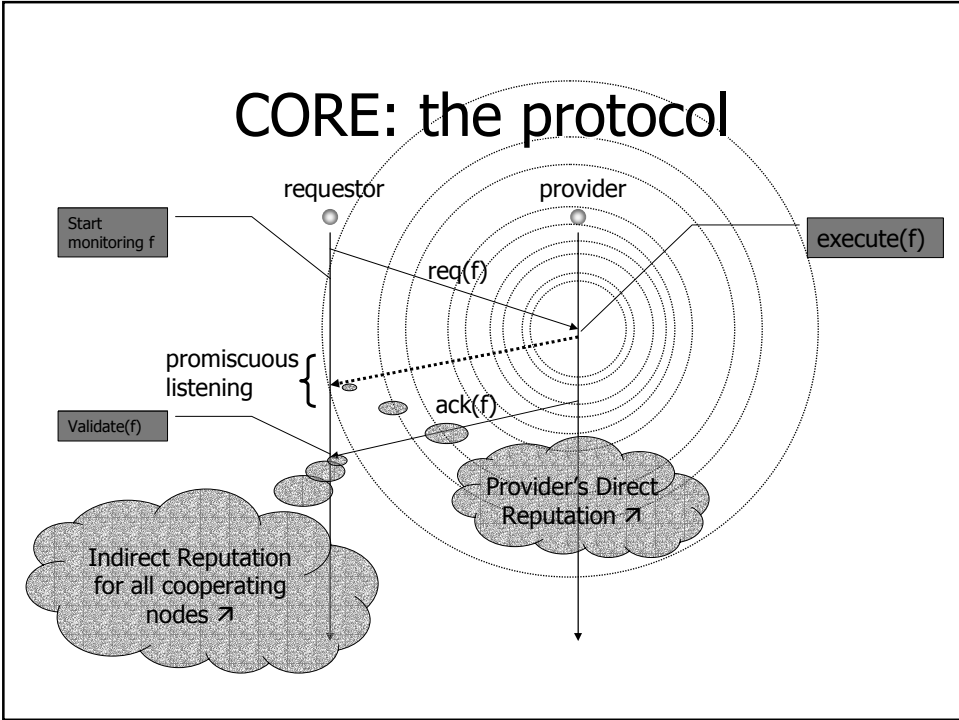
Basic idea:

good reputation \Rightarrow node can use the network

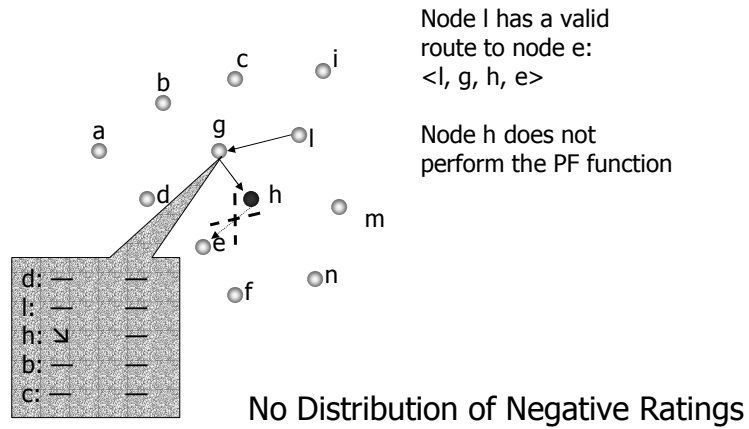
bad reputation \Rightarrow network utilization gradually denied



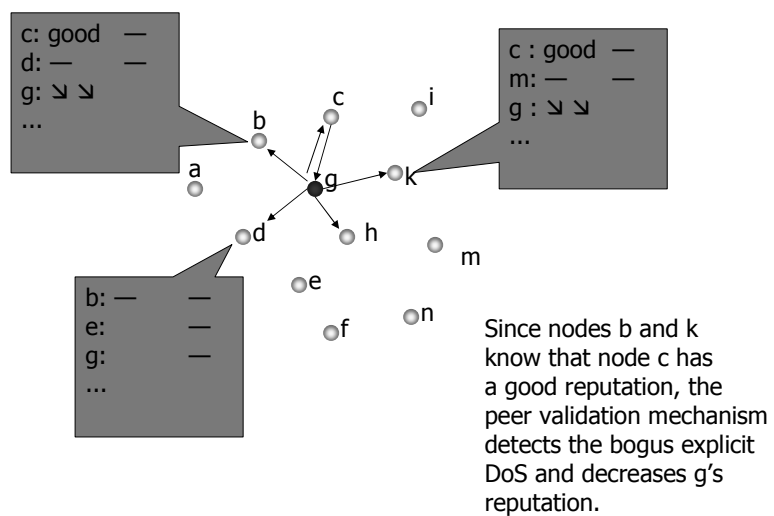
Isolation of misbehaving nodes



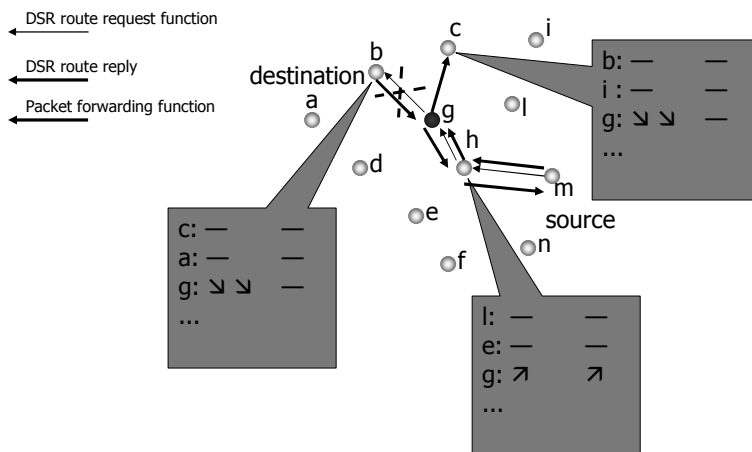
Black Hole (Passive DoS)



DoS using CORE? (active DoS)



Traffic subversion (active DoS)



CORE: Properties

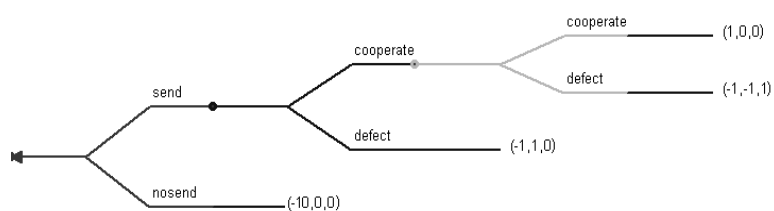
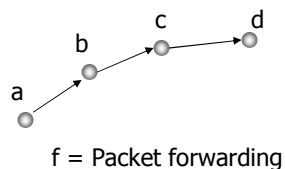
- Passive DoS attacks are detected and cooperation is enforced
- Active DoS attacks are prevented

Peer validation
+
No rating distribution → DoS attacks exploiting CORE
are prevented

- Decaying of reputation
- Reputation is hard to build
- No additional traffic

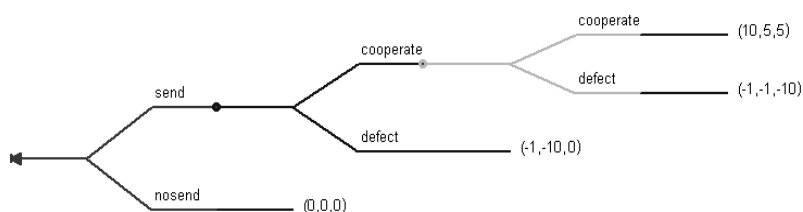
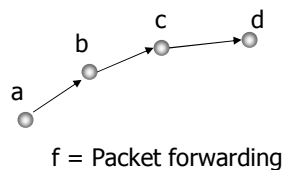
Game Theory Example MANET

- m-dimensional prisoner's dilemma
 - sequential game
 - players = {a, b, c}
 - Set of actions {cooperate, defect}
 - Players' choice based on **utility function**
- BEST STRATEGY: defect



Game Theory Example MANET with CORE

- Find a utility function that reflects the reputation mechanism
- Show that best strategy is to cooperate



Utility Function

- Equity, reciprocity and competition (ERC)

- large group of players

utility function : $\alpha_i u(y_i) + \beta_i r(\sigma_i)$

relative share : $\sigma_i = \frac{y_i}{\sum_j y_j}$

One-shot PD Game

Cooperation payoff $y_i = B(k) - C(k)$

Defection payoff $y_i = B(k)$

N nodes, k cooperate

Utility(cooperate):

$$\alpha_i u[B(k+1) - C(k+1)] + \beta_i r \left[\frac{B(k+1) - C(k+1)}{N \cdot B(k+1) - (k+1)C(k+1)} \right]$$

Utility(defect):

$$\alpha_i u[B(k)] + \beta_i r \left[\frac{B(k)}{N \cdot B(k) - k \cdot C(k)} \right]$$

Incentive Structure based on CORE

A1. Cooperation is socially desirable:

$$N \cdot B(k + 1) - (k + 1)C(k + 1) \geq N \cdot B(k) - k \cdot C(k)$$

A2. Cooperation is individually desirable:

$$B(k + 1) - C(k + 1) \geq B(k) - C(k)$$

Analysis (based on A1 and A2):

- Utility(cooperate) \geq Utility(defect)
- Solutions (Nash equilibrium): $k = 0$ and $k \geq N/2$

Future work

- Further investigation of ERC types (α, β)
- Incentive structures (Shapley value)
- Further validation by simulation NS \rightarrow QualNet
- Performance evaluation.