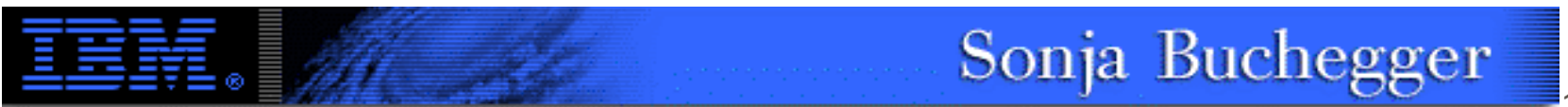


Malice, Selfishness, and Slander in Mobile ad-hoc Networks

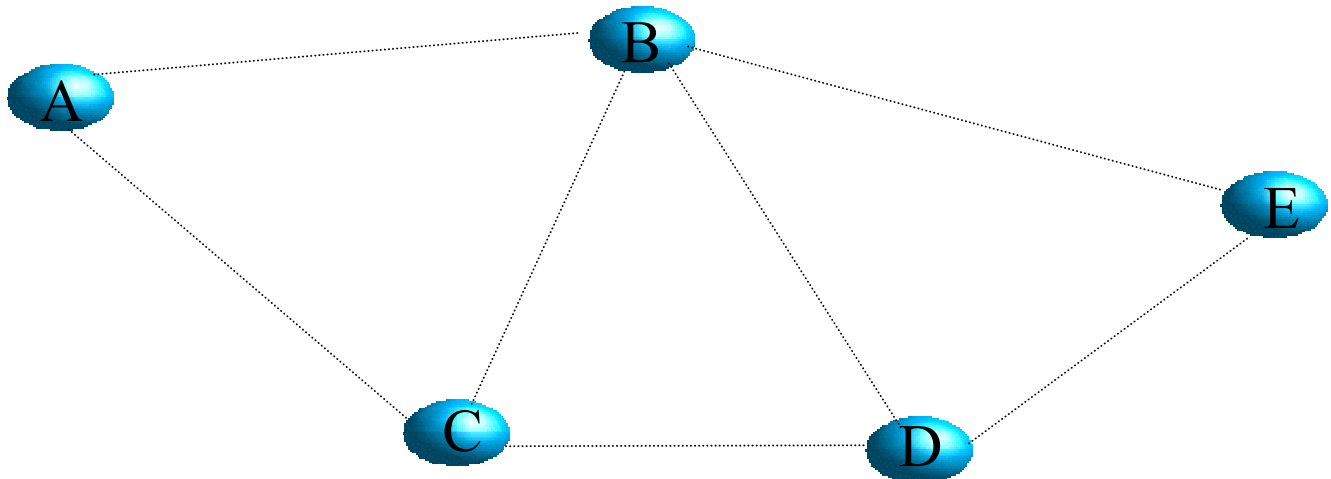
Sonja Buchegger, IBM Zurich Research Laboratory
EPFL

Dagstuhl, August 2002



What's the Problem?

- Self-organized mobile ad hoc networks
 - need to cooperate to communicate
 - trade-off between service availability and resource consumption.



Motivation for Routing Misbehavior

- Mobile ad-hoc networks assume the cooperation of nodes for routing, although it is an open world and anyone can join.
- However, there are many reasons for non-cooperation:
 - Get better service than cooperating nodes
 - Monetary benefits by exploiting incentive measures
 - Analysis and trading of confidential information
 - Save power by selfish behavior
 - Denial-of-service

Why Cooperate?

Why is there altruism without instant benefit?

When Nodes Bear Grudges

- "The Selfish Gene" (Richard Dawkins):

Why is there altruism without instant gratification?

- Survival of birds with cost/benefit function:

- **selfish (cheats)** vs. **altruistic (suckers)** birds:
cheats win over time but then go extinct, too.

- new kind of bird: **careful (grudgers)**.

- help at first, then reciprocate:

- first **suckers**, then **cheats** go extinct,
grudgers survive



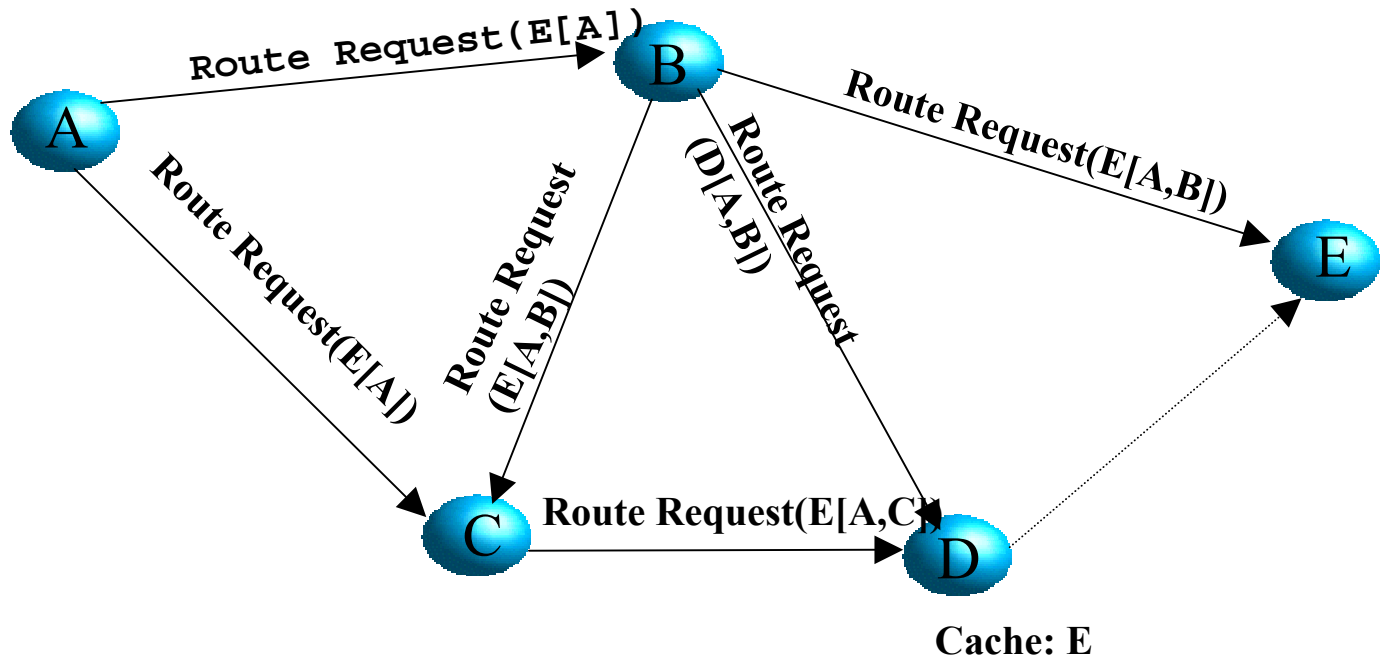
Grudger Nodes in MANET: The CONFIDANT Protocol

- Learn from **observed and reported** experience:
 - **Nodes monitor their neighbors**
 - **Nodes keep reputation records by**
 - **first-hand observations**
 - **ALARMs received and trusted**
 - **Nodes keep trust records to control**
 - **trust given to received ALARMs**
 - **whom to send ALARMs to (list of friends)**
 - **Nodes adapt their behavior according to reputation**

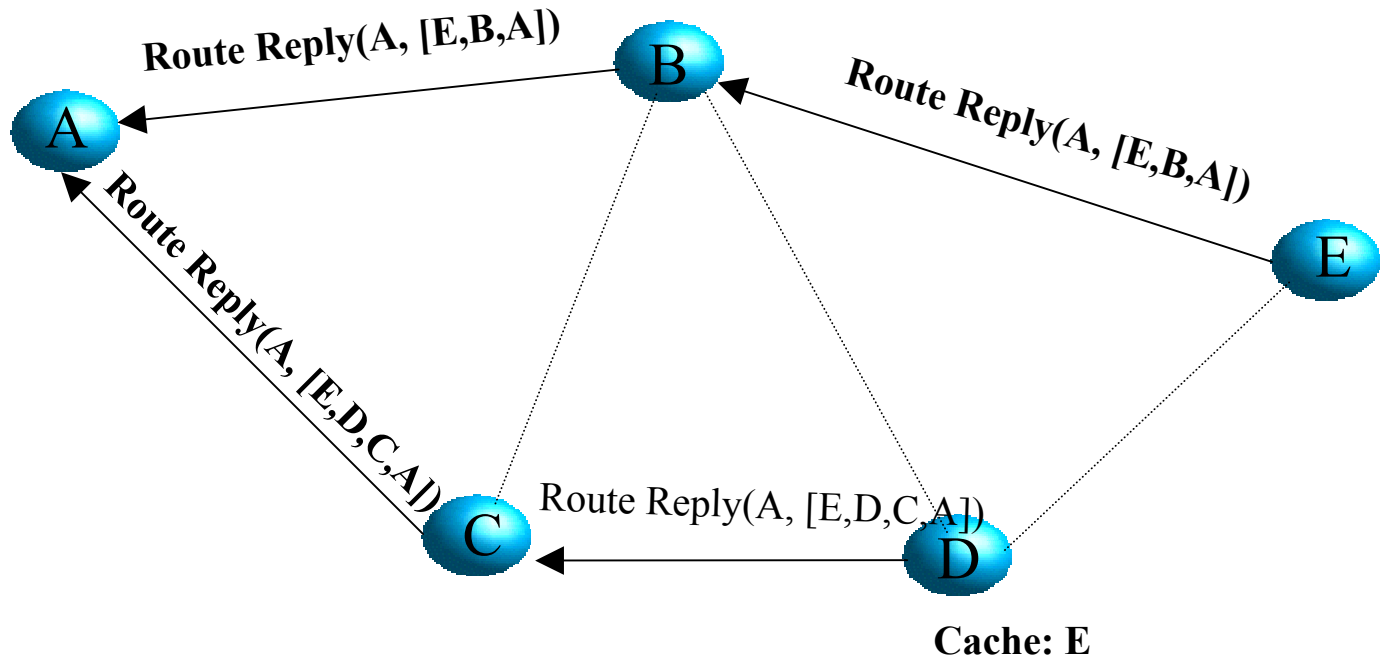
Purpose of CONFIDANT

- CONFIDANT detects malicious nodes
 - by means of observation or reports about several types of attacks
- and thus allows nodes
 - to route around misbehaved nodes and
 - to isolate misbehaved nodes from the network, so that misbehavior does not pay off.

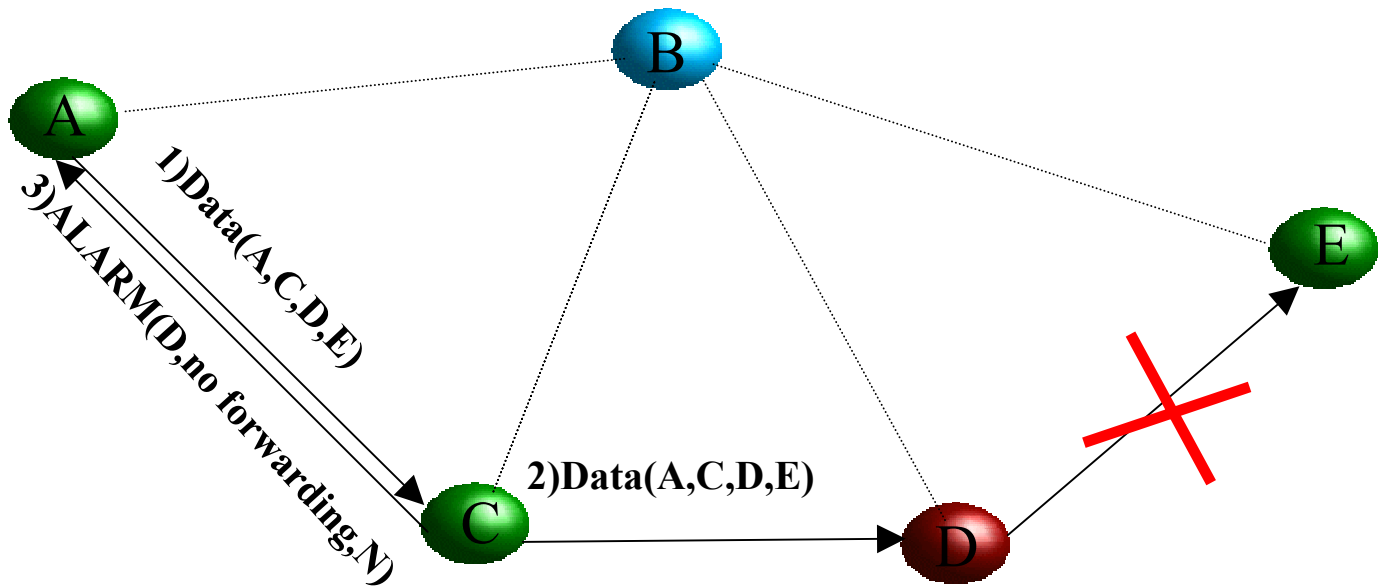
CONFIDANT with DSR - Route Request



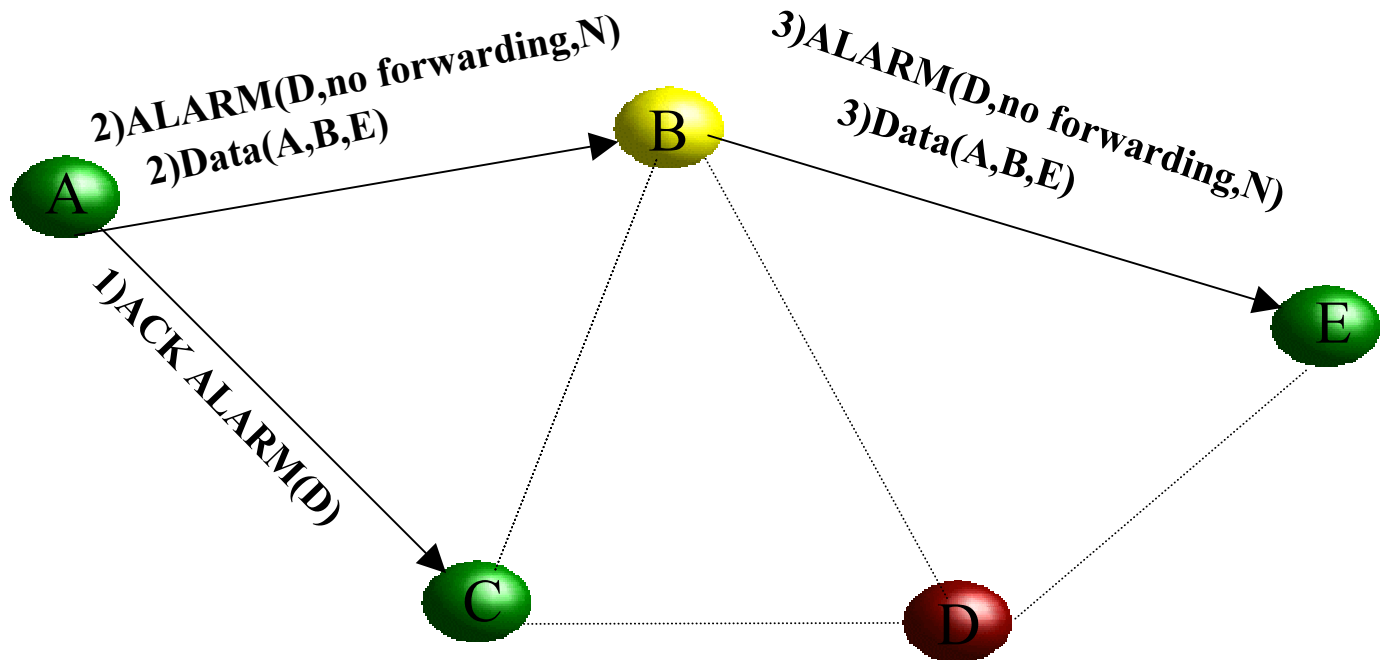
CONFIDANT with DSR - Route Reply



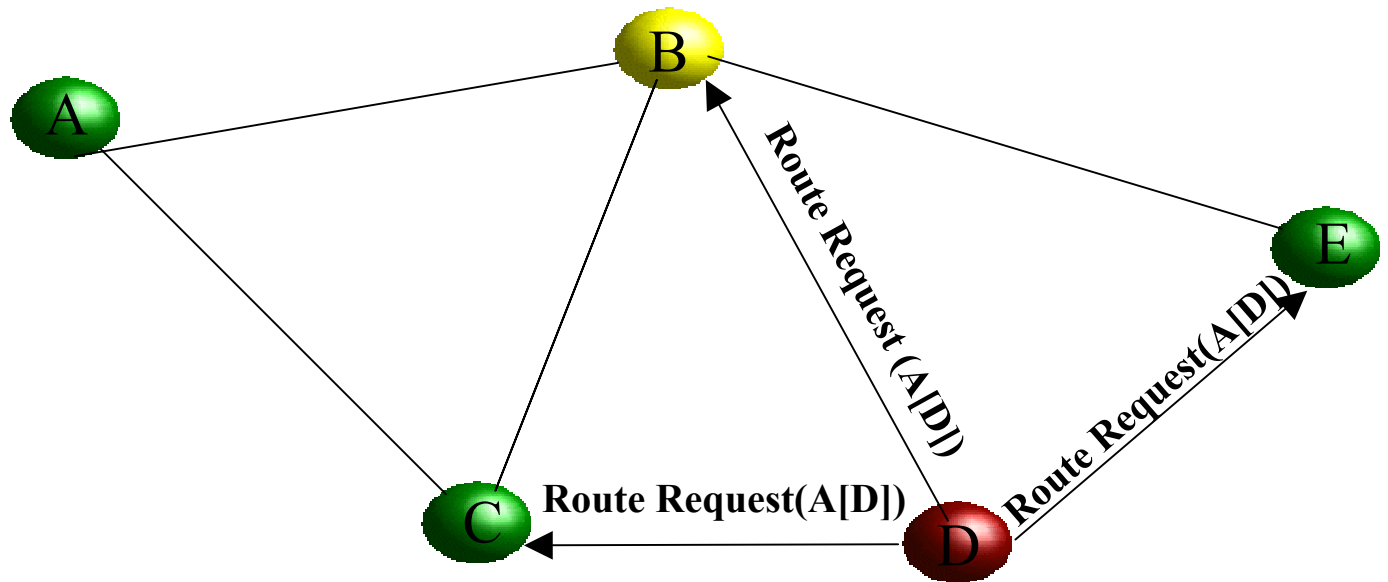
CONFIDANT with DSR - Alarm



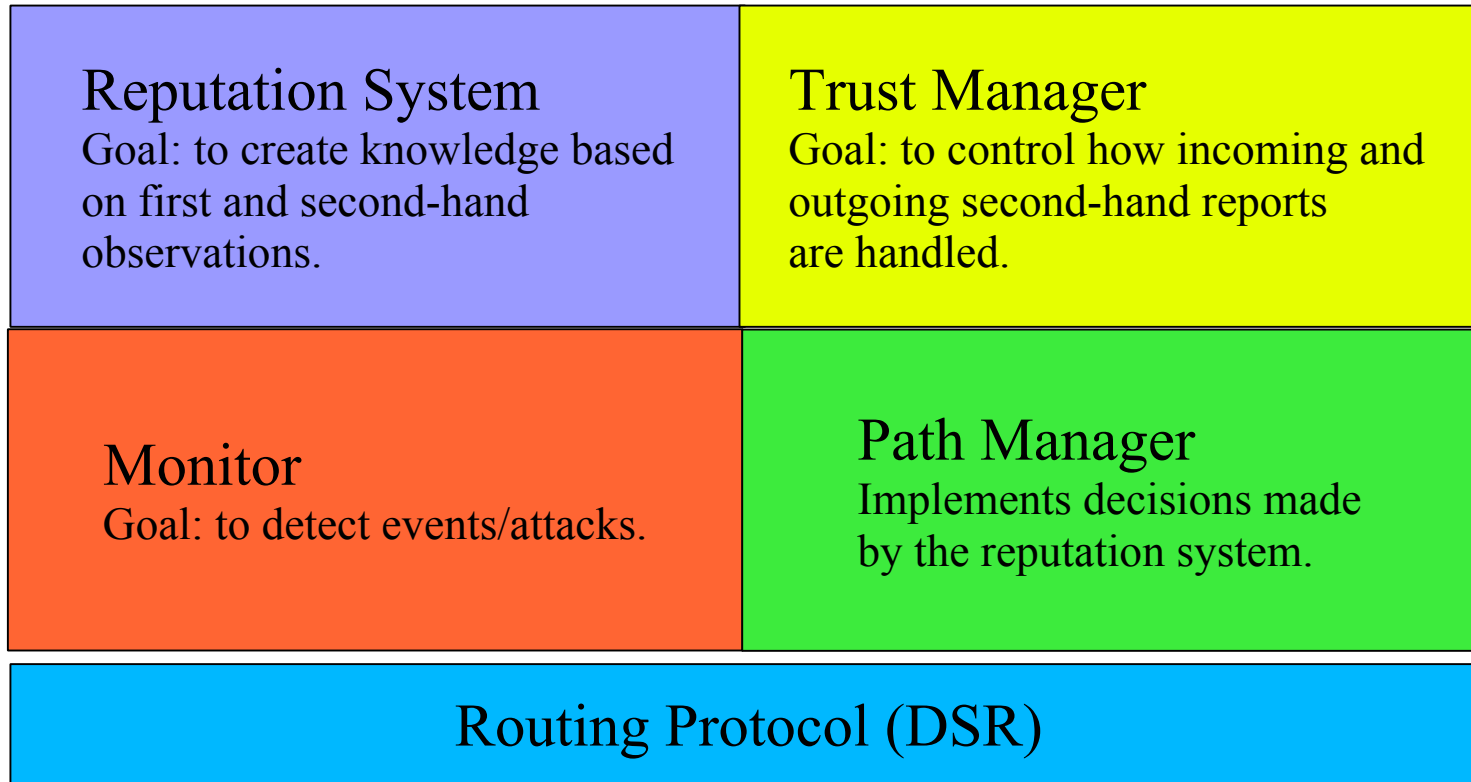
CONFIDANT with DSR - Reroute



CONFIDANT with DSR - Isolation



CONFIDANT Components



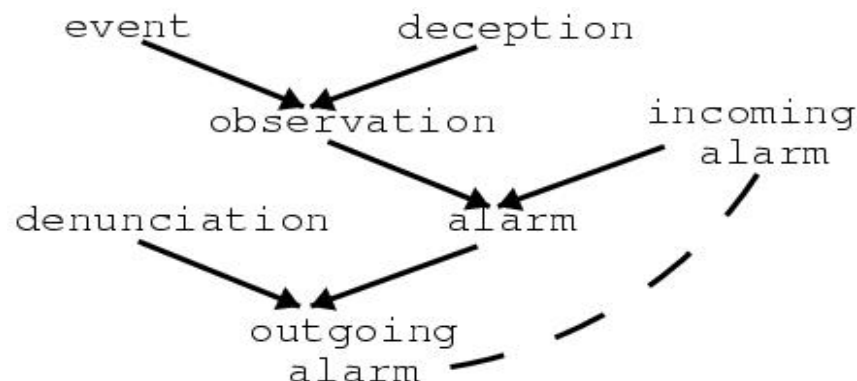
How to win friends and influence nodes

□ Robustness against

- wrong accusations
- wrong observations
- trusting wrong nodes
- free riding

□ Trust dynamics

- one approach: Bayesian estimation
- combining/comparing beliefs of several nodes
 - how many? Which ones?



Ongoing Work

- Bayesian estimation for decision-making – minimize risk/loss for
 - Classification of observations/alarms
 - Reputation
 - Trust
 - Model comparison
- Game Theory

Questions?

Papers on <http://www.terminodes.org>
and <http://www.zurich.ibm.com/~sob>